Volume 10 Number 3

COMMONWEALTH OF AUSTRALIA



# JOURNAL

OF

# THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

AUGUST, 1937

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# Council for Scientific and Industrial Research




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*East Melbourne,*
*Victoria*

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Editor: G. A. COOK, M.Sc., B.M.E.

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# The Lantana Bug, *Teleonemia lantanae* Distant.

*By R. V. Fyfe, B.Sc. Agr.**

*Summary.*

The Council for Scientific and Industrial Research introduced the lantana bug, *Teleonemia lantanae* Dist., into Australia, at the end of 1935, to assist in the control of the lantana weed. This insect is a small plant-feeding bug belonging to the family Tingitidae. The bugs feed on the leaves, flowers, and young stems, by means of a beak which pierces the plant tissue and through which the contents of the plant cells are sucked. The feeding causes the death of the plant part attacked

Tests have shown that the lantana bug cannot feed or develop on plants other than those belonging to the genus *Lantana*.

At the present time, attempts are being made to establish *T. lantanae* in selected localities in Australia, and on Norfolk Island, from stocks bred in the insectaries of the Division of Economic Entomology, Canberra.

## 1. Introduction.

The lantana plant, a member of the family Verbenaceae, grows into a profusely branched shrub often to the height of 15 feet. Large numbers of these plants growing side by side form dense impenetrable thickets which often cover large tracts of valuable country. The species *Lantana camara* has become an important weed in the coastal regions of tropical and sub-tropical eastern Australia. It is a native of tropical America, and, because of the abundance and beauty of its flowers, it has been introduced into other parts of the world and in many places has become a weed of considerable importance. In new countries, its rapid spread has been aided by birds which have fed on its succulent berries and have carried the seed to new areas.

The first attempt to control lantana by means of its insect enemies was made in 1902, when Koebele introduced a number of insects, including *T. lantanae,* into the Hawaiian Islands from Mexico (Perkins and Swezey, 1924). In 1928, the Government Entomologist of Fiji, while travelling in Hawaii, was so impressed by the way in which *T. lantanae* bugs were defoliating lantana bushes, that he took back to Fiji a large consignment of these insects and liberated them in Viti Levu, Fiji, in the same year (Simmonds, 1928). During the latter part of 1935, the life-history and feeding habits of the insect were studied by the author in Fiji before it was introduced into Australia and placed in quarantine insectaries at Canberra.

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## 2. Life-History and Habits.

*Teleonemia lantanae* belongs to the family of lace-bugs, the Tingitidae, sub-order Heteroptera of the order Hemiptera, the members of which are characterized by piercing and sucking mouth parts.

*T. lantanae* has been described by Distant (1907). The adult bug is a small brown insect, approximately 3.5 mm. in length (Pl. 1, Fig. 1). The forewings have an intricate and raised lacework pattern. The pronotum, which extends backwards over the thorax well beyond the bases of the wings, is closely punctured and bears dorsally three prominent longitudinal ridges. The nymphs, very different from the adults in general appearance, are small, dull-coloured insects with lateral abdominal spines (Pl. 1, Fig. 1).

The life-history studies described in this section were made in Suva, Fiji, during a period when the temperature varied between 70°F. and 85°F., and the relative humidity between 70 per cent. and 95 per cent. The insects were fed on leaves of *Lantana crocea* which is the predominant species in Fiji. Life-history studies of this insect were first carried out by Simmonds (1929).

*T. lantanae* possesses an incomplete type of life-cycle, for there is no pupa or resting stage in its development after hatching from the egg. The eggs are laid in the tissue of either the midrib or one of the main veins on the under surface of succulent leaves, usually in those at the end of a young actively growing shoot. One end of the egg is produced into a tube at the end of which is a cap-like operculum. When the egg is inserted into the vein, the tubular part is left projecting above the surface and is covered by a viscid substance which forms a white cone-like elevation on the vein (Pl. 1, Fig. 2). The eggs are usually laid in clusters of from 10 to 30 in the one vein, although at times they may be scattered over several veins on the one leaf. The presence of the eggs in the tissue of the vein at first causes cork production and, later, the death of the adjacent plant cells. This tissue ceases to grow, and, with continued multiplication and growth of cells on the upper surface, the leaf becomes much distorted (Pl. 2, Fig. 1).

In a warm humid atmosphere the eggs hatch seven or eight days after being laid, usually between 8 and 9 a.m., and the young emerge by pushing open the operculum at the top of the cone-like elevation. The newly emerged nymph is very small and is at first white in colour with red eyes. Soon after hatching, it moves from the vein to the green tissue of the leaf and commences to feed. Gradually the cuticle hardens and the bug becomes light brown in colour. Usually, all the eggs in a cluster do not hatch at once, but hatch over a period of several days. This suggests that all eggs in a cluster are not laid at the same time. There is soon formed a colony of nymphs at various stages of development feeding actively on the under surface of the leaf.

There are five nymphal instars which are similar in appearance except for size and the presence of wing buds in the fourth and fifth stages. At temperatures varying between 70°F. and 77°F., the bugs reach the adult stage in from 15 to 18 days, but between 77°F. and 85°F. only 12 to 15 days are required. The younger nymphs are very sluggish and rarely migrate to leaves beyond those adjacent to the one

on which they have hatched. If a large colony hatches on a small leaf, the young bugs move to the larger adjacent leaves. The fifth stage nymphs are more active and wander to other parts of the same branch. Nevertheless, when about to undergo the final moult, they invariably return to the under surface of a leaf to cling on to the prominent veins and there undergo metamorphosis. The newly moulted adult is white with bright red eyes, but it assumes the normal brown colour within two or three hours. A day or two after reaching maturity, the insects migrate to the flowers and flower buds. The flowers are produced in close clusters of 25 to 50 and form corymbose heads borne at the top of long axillary peduncles. The flower is small and tubular, and, distally, is divided into five unequal lobes. In mature inflorescences the adult bugs attack the individual flowers and feed mainly on the tubular part. In the absence of flowers they continue to feed on the leaves and stems, mainly at the growing tips.

The females are fertilized within the first few days after becoming adult, and usually commence to oviposit about the fifth or sixth day. At temperatures varying between 70°F. and 85°F., the life-cycle is completed in between three and four weeks. Thus with an abundance of suitable food, and under tropical conditions, *T. lantanae* can multiply very rapidly. As the adults fly very actively, especially on hot sunny days, the bugs are capable of spreading over large masses of lantana in a comparatively short time. Adults kept under observation in the insectary lived for periods up to three months. Consequently, there may be at least three generations of bugs feeding on a clump of lantana at any one time.

### 3. The Feeding of *T. lantanae* and Its Effect on Lantana Plants.

The mouth parts of *T. lantanae* in all stages are exclusively adapted for piercing and sucking. The mandibles and maxillae are modified to form slender bristle-like stylets which are enclosed in a rostrum or beak. By means of the serrated mandibular stylets, the insect pierces the plant tissue, and the contents of the cells are then drawn up through the beak into the alimentary canal for digestion. The bugs suck up the entire cell contents so that the mid-gut of insects which have been feeding on a leaf is always coloured with chlorophyll, and that of insects feeding on flowers with orange coloured chromoplasts.

The presence of newly hatched nymphs feeding on the under side of a leaf soon becomes apparent from above. The upper surface becomes marked with white speckled areas from which the chlorophyll has been removed. As the nymphs increase in size and in numbers, they spread over the under surface of the leaf which becomes covered with the bugs' excreta in the form of small black dots (Pl. 2. Fig. 2). The upper surface becomes more bleached and in time the leaf turns brown, commencing from the tips and margins. A heavily infested plant, at this stage, presents the appearance of having been scorched by fire (Pl. 3, Fig. 1). Eventually, the attacked leaves die, curl, and fall off (Pl. 3, Fig. 2).

The adults always, and the nymphs occasionally, feed greedily on all buds and flowers available. When young flower buds are attacked before the inflorescence has opened out, the whole head is killed and blackens

within a day or two. In a cluster bearing separated and mature flowers, the individual flowers are pierced and soon killed. On heavily infested bushes, therefore, the flower buds and flowers are destroyed. In this way the lantana bug reduces seed production and helps to prevent the spread of the weed.

Observations made on the reproduction of *T. lantanae* in cages suggested that the feeding on the flowers by the adults may be a limiting factor in normal egg production. Preliminary experiments conducted to show this, have indicated that bugs fed only on plants without flowers are able to lay eggs but are not able to lay as many as bugs fed on flowering plants.

After a time, besides affecting each particular part attacked, the feeding of *T. lantanae* apparently systemically affects the growth of the plant as a whole. Young terminal growth, and young stems which show no signs of having been attacked themselves, become distorted, turn yellow, and cease to grow. In the field, adult insects leave plants which have reached this stage, but insects confined in cages will continue their feeding with the result that all parts of the plant eventually turn yellow. The leaves fall but the stems, if freed from the bugs, can in time give rise to new growth. Adventitious shoots appear around the crown, and later fresh shoots arise from the stems. If there is a large population of bugs on adjacent plants, these new growths, which appear particularly attractive to the bugs, are attacked again.

The mechanical removal of tissue from either the leaves or the flowers does not seem sufficient to account for the blackening of tissue which sometimes occurs some distance from a feeding puncture. It has been demonstrated by Smith (1920), that the saliva which is injected into the feeding puncture by the Capsid bug *Plesiocoris rugicollis,* when it feeds on leaves and fruit of the apple, has a violently toxic action on the plant cells. It seems probable that the lantana bug also injects into the feeding punctures saliva which has a toxic action on the tissues of lantana plants.

## 4. The Restricted Feeding Habits of *T. lantanae*.

Exhaustive tests were carried out, in Fiji and at Canberra, to ascertain whether in any circumstances *T. lantanae* could be induced to feed or oviposit on any plant of economic importance. Negative results were obtained with all plants other than ornamental lantana. The lantana bug feeds on cultivated varieties, and these plants have been used in the insectaries for breeding purposes because of the large number of flowers produced by them. In spite of this undesirable feeding habit, it was felt that if this insect should prove effective in those areas where the lantana problem is serious, any inconvenience caused to the owners of the ornamental variety would be outweighed by the benefit derived from its liberation.

## 5. Natural Enemies.

In Fiji, the numbers of *T. lantanae* are considerably reduced by natural enemies, the chief of which appears to be the predatory Lygaeid bug, *Germalus pacificus,* Kirk., which feeds on lantana berries as well as on nymphs of the lantana bug (Simmonds, 1929). *T. lantanae* is also preyed upon by spiders, Coccinellid beetles, and Neuropterous larvae.

A fungal parasite *Hirsutella* sp. is also of importance in Fiji (Fyfe, 1936). It not only infects the adult bugs, but also the 5th stage nymphs (Pl. 4, Fig. 1).

In Australia, a natural enemy has already been found at Canberra. It is an Assasin bug, *Nabis* (?) *capsiformis* Germ., of the family Reduviidae which pierces the bugs and sucks out the body contents (Pl. 4, Fig. 2). Thus it behaves in a manner similar to *Germalus pacificus,* but, whereas *G. pacificus* is only slightly larger than an adult lantana bug and has only been seen feeding on the nymphs, the Reduviid is many times larger than *T. lantanae* and readily attacks and kills adults as well as nymphs. The sluggish movements and congregating habits of the lantana bug make it an easy prey for its usually more active predatory enemies.

## 6. Introduction and Transportation.

Because of the presence of these natural enemies in Fiji, special precautions were taken to avoid introducing them into Australia with *T. lantanae.* The bugs were sent from Fiji to Canberra in two different ways, one with plant food and the other without. Bugs supplied only with moisture from a cotton wool pad connected by a wick to water and kept at a temperature of approximately 55°F., survived a six-day period with about 25 per cent. mortality. In the other method, bugs were placed on plants in a cubical cage 3 feet wide, enclosed with organdie muslin and shipped as deck cargo. In the quarantine insectaries at Canberra, the bugs were transferred to fresh plants and the young as they hatched were treated similarly.

To destroy any spores of the parasitic fungus which may have been present, all imported adults, about 40 at a time, were confined in a cage of perforated celluloid and were dipped in a solution of 0.2 per cent. mercuric chloride in 70 per cent. alcohol for 30 seconds. They were subsequently quickly dipped in distilled water and then placed on blotting paper in the sun. After two or three minutes they revived, the mortality being about 10 per cent.

In sending large consignments of the lantana bug from Canberra to distant parts of Queensland and to Norfolk Island, the following method proved satisfactory. A pad of moist cotton wool was placed in the inverted lid of a petri dish; a lantana leaf was pinned to the pad, and 40 or 50 adult bugs were put on the leaf. The bottom dish was then held in place with rubber bands thus holding the pad firmly between the rim and the lid.

## 7. The Present Position.

The lantana bug has been found to be restricted in its feeding to the genus *Lantana.* The bugs have been bred in large numbers in quarantine and have been freed from parasitic fungi. To date, two preliminary liberations have been made in Australia, one at Grafton, New South Wales, in October, 1936, and the other at Atherton, Queensland, in November, 1936.

These preliminary liberations have been made in accordance with the policy of the Division of Economic Entomology, which is to concentrate at first on establishing insect introductions in two or three

places where they can be kept under close observation. If the lantana bug becomes established and shows promise of controlling the weed in these areas, it will later be distributed to other places infested with lantana.

In these preliminary trials, the colonies have disappeared. Further attempts will be made to establish the bugs in the field as supplies become available.

More recently (May, 1937), supplies of *T. lantanae* were despatched to, and liberated on, Norfolk Island. It is probable that on this island with its limited fauna the bugs may be less affected by natural enemies and have a much greater chance of establishing themselves.

## 8. Conclusion.

These studies indicate that if *T. lantanae* becomes established and flourishes in this country, it may be expected to reduce seriously the vigour of individual lantana plants. This should often give competing plants an advantage which would enable them to displace the lantana. On a heavily infested plant, the attack may be severe enough to defoliate it and to kill it directly. As the bugs destroy the flowers and flower buds, they will limit seed production, and, consequently, check the spread of the lantana pest.

## 9. Acknowledgments.

The author takes this opportunity of acknowledging the Division's indebtedness to the Fiji Department of Agriculture, for providing laboratory accommodation and other facilities for the work in Fiji. Thanks are due especially to Mr. H. W. Simmonds, Government Entomologist, Fiji, who generously assisted the author in every way possible. At Canberra, the work was continued under the helpful supervision of Dr. G. A. Currie.

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# Recent Developments in the Photographic Copying of Published Articles.

*By H. E. Dadswell, M.Sc., A.A.C.I.**

The research worker is often handicapped because there is no ready means of reference to the available literature on the subject in which he is interested. Sometimes, it is possible to obtain reprints from authors, but this can be done only in a few cases. The libraries to which he has access may not take all the periodicals dealing with the particular subject, or, if they do, it may not be possible to borrow the books for long.

When absolutely essential, arrangements can often be made to have particular references forwarded from other centres, but librarians do not favour this procedure, as there is always the danger of damage in transit or of the loss of an irreplaceable volume. In Australia, each library cannot afford to take the full range of publications which the more financial institutions overseas do, and it is often necessary to arrange for the loan of particular references from another institution with consequent risk of damage or loss. The research worker is forced to make brief abstracts from such borrowed volumes, but such abstracts can never take the place of the full article.

If the complete article is necessary, it can of course be copied. However, typed copies are very expensive and not always satisfactory, especially when the typist has to copy from languages other than English. The usual photographic (photostatic) methods may be resorted to, but these often prove too expensive for the research worker, especially if the article to be copied is a long one.

In other countries, the whole question of cheap and comparatively simple methods of photographic reproduction of scientific papers has received considerable attention in the last three or four years. Costs have been lowered by reducing considerably the size of the negative. Van Iterson (1) has described an ingenious method whereby a reproduction of eighteen printed pages is obtained on one plate of size 13 x 18 cm. This is accomplished by photographing two open pages of a book at the one time on a small area of the plate (3.6 x 5.1 cm.). By suitable adjusting arrangements, nine reproductions of the open book may be obtained successively on the desired places of the photographic plate. Thus, in order to obtain a reproduction of eighteen pages, only one plate has to be handled, developed, &c. The reading of these prints has to be accomplished by low-power binoculars or by a special monocular reading device.

In the United States of America, the recent advances in simple and cheap methods of photographic reproduction have been in the use of small cameras by means of which one printed page is copied on standard 35 mm. cinema film. This development was undoubtedly influenced by the increased use of miniature cameras for general photographic work. The advantages of such cameras for copying were quickly appreciated; they give sharp definition, it is possible to make up to 40 exposures on the one roll of film, and processing is comparatively

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simple. The makers of one of the miniature cameras, which has been very widely used for copying work, have developed accessories which made copying very simple. They have also designed a camera which could take enough film for 250 exposures.

By this means, it is possible to obtain negative film strips which can be used to make photographic prints or positive film strips. Either the negative or the positive film strip can be read by low-power binoculars or by projection methods. The film strip, positive or negative, can be simply filed by placing in envelopes with necessary notes on the outside, or they can be mounted over windows in filing cards.

The possibilities and advantages of these methods are such that the development of suitable apparatus for use in large libraries has been extremely rapid. These developments are the result of the co-operation between the Library of the United States Department of Agriculture, the National Institute of Health, and Science Service. Descriptions of the various details and advancements and discussions of the possibilities of method have been published in the last three years by Atherton Seidell (2) of the National Institute of Health, and Watson Davis (3) of Science Service.

The Documentation Division of Science Service has been formed, and it is now possible to obtain through the Library of the U.S. Department of Agriculture photo-copies of any published article. Either photo-prints or film strips are supplied as desired. Charges are very reasonable. In addition to a service charge of 10 cents (5d.) film copies are priced at 1 cent. (½d.) per page, and photo copies, 6 inches x 8 inches in size, at 5 cents (2½.) per page with a minimum charge of 25 cents (1s.). These are the figures given by Davis (3) in his article of May, 1936, but it is possible that there may be an increase in the near future. Even so, it must be admitted that photographic reproductions of any article are, in the United States at least, well within the means of any research worker. Thus even the material in very valuable and comparatively inaccessible volumes can readily be made available to those interested.

The photographic apparatus for use in a large library is necessarily specialised, but it must be easy and simple to handle and wherever possible automatic. According to Davis, the apparatus in use or being developed in 1936 consisted of the following:—

(i) A camera for copying typescripts, books, photographs, etc., upon 35 mm. film* (in use).

(ii) A supplementary apparatus for camera such as book holder,* film container, etc. (models completed).

(iii) A reading machine—about size of typewriter, producing large-sized easily readable image of 35 mm. films (models completed).

(iv) A microfilm viewer—a small monocular optical device for reading 35 mm. film a line at a time (design completed).

(v) A projection printer—automatic device for producing photo-copies (enlargements on paper) from 35 mm. microfilm negatives* (under design).

(vi) Developing and processing apparatus for 35 mm. film and paper projection prints* (in use and under design).

* Primarily intended for use in microphotographic laboratories.

It is hoped to extend this Bibliofilm Service to other libraries with the idea of making more readily available copies of any scientific paper to which a research worker may find it necessary to refer. Also, it is hoped that such a Publication Service will be extended much further and be used to distribute copies of scientific literature which cannot now be printed owing to the high costs of production. Thus it would become supplementary to the ordinary channels of publication.

In Australia, there is as yet no central body or organization which is in a position to develop such up-to-date methods of reproduction. It has been found, however, that there is a growing need for such a service to research workers. For example, the activities of the Council for Scientific and Industrial Research are at the present time widespread and workers are located in widely-separated parts of Australia. These officers need from time to time to refer to publications which are not readily available to them. To meet their needs and also the needs of research workers of other organizations as well as those of independent workers, the Library of the Council has, with the assistance of the Photographic Section of the Division of Forest Products, developed a modified copy service. This has been in operation for some fifteen months, and has aroused such interest that some description of the apparatus and procedure seems warranted.

Essentially, the apparatus used consists of a standard Leica camera with a special sliding focussing attachment. This attachment permits the sharp focussing of the object or document on the ground glass which is in the same horizontal plane as the film in the camera. After focussing, the camera may be easily moved over the lens—see Fig. 1. Camera and focussing arrangement are attached to an arm which can be moved up and down the vertical upright of the stand. The latter consists

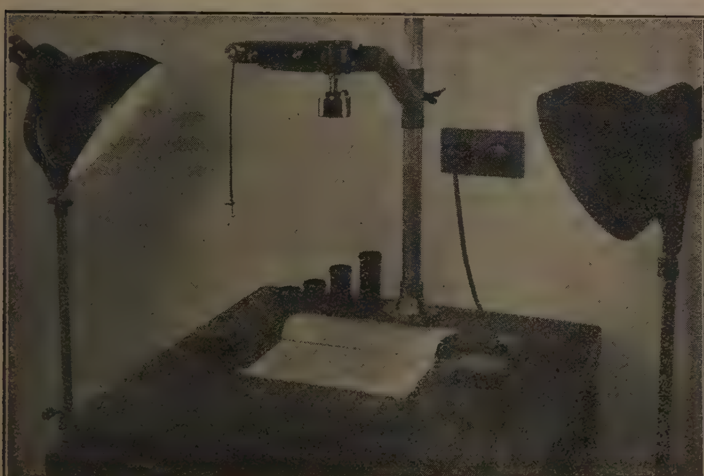


Fig. 1.—Apparatus for the photographing of printed matter.

of a wooden baseboard 24 inches square and upright of 1¼-in. steel rod. The printed material to be copied is kept flat under a glass plate and illuminated by two 500 watt Nitraphot globes fitted with reflectors. Even illumination is essential for the best results. Coarse focussing is accomplished by moving the apparatus up and down the upright, while the fine focussing is done with the camera lens. To get the best definition, this final focussing should be assisted by an 8X hand lens. When properly focussed, the camera is moved over into position and the exposure made. It is necessary to check the focus only every ten or twelve pages, as the thickness of several pages of the journal causes a little variation. The film used is the ordinary positive 35 mm. moving picture film which may be procured in lengths of 100 feet. It is cut to the required length in the dark room. Sometimes enough film for 40 exposures is loaded, but more often only sufficient for the publications to be copied is used. It must be realised that, at the present time, the copying work is done along with the ordinary photographic work of the Division. The exposure with the illumination described is usually fixed at 1 sec., and variations obtained by altering the stop of the lens from f9 to f15 depending on the size and nature of the journal to be copied. An average exposure has been found to be 1 sec. at f12.5. Stopping the lens down to this point increases the sharpness of the negative.

Either the 90 mm. long focus lens or the 50 mm. lens usually supplied with the camera is equally effective, although most of the work has been done with the former. In both cases a lens hood should be fitted. Development of the film is carried out in a process developer for 2 minutes at 65° F. For films with over 20 exposures, tank development is advisable; otherwise, hand manipulation is sufficient. It has been found advisable to run through a trial strip to obtain the correct conditions of lighting, exposure, etc. This ensures the best negative for even printing.

In the great majority of cases, half plate (6½-in. x 4¾-in.) print copies are made, using the standard automatic enlarger; if necessary, the print can be made whole plate size (6½in. x 8½-in.) or even larger. The paper used is a light weight matte bromide placed on the market by Kodak Australia Ltd. under the name Bromide B. The even exposure and uniform development of the film ensure that the same exposure can be used for each enlargement, thus making the printing a more or less routine matter. Very sharp clear negatives are obtained, and these stand enlargement well over 10 times. An example of the work is shown in Fig. 2, the contact print being included for comparison.

It will be seen from Fig. 1 that only one page of the publication is taken at the one time, that is one page per Leica frame of a size 1½ inch x 1 inch. It would be possible to copy two pages of the publication on this size negative, as they do in the Bibliofilm Service, but it has been found that with the equipment available it is easier to handle the large journals, and more even illumination is possible when the one page only is photographed. Very little time is lost, and the resulting negative has better definition.

have been obtained. In addition, the South Australian Department of Lands have records, for the last five years, from a number of observation holes in various parts of the Renmark areas. The observations so far obtained indicate that for these particular Renmark soils:—

(i) the water table can be continuously followed right to the creek or river (Fig. 3);

(ii) water levels on irrigated country rise with irrigation. (The fluctuations are similar to those shown in Fig. 2.)

(iii) general water levels have been steadily rising for the last five years;

(iv) as a rule, the table is higher in irrigated country than in the surrounding un-irrigated land, even though the latter is on a lower contour.

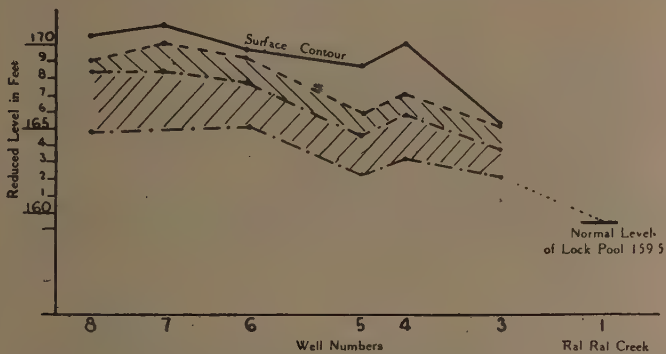
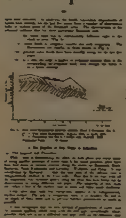



FIG. 3.—Free water fluctuations (interim results). Block E Renmark. Sec. B.
// = Free water fluctuations, August, 1935, to April, 1936.
⟍ = Temporary rise due to 5 inches rain, January, 1936.
Horizontal Scale, 1″ = 50 chains.

## 4. The Relation of Free Water to Irrigation.

### (a) *Plot Lay-out and Procedure.*

With a view to determining the effect, on both plant and water table, of using smaller amounts of water than is the usual practice, plots have been laid down in various centres along the river—at Renmark, Berri, Barmera, (both Nookamka and Loveday), Waikerie, and Pyap. It was established by Barnard (1) that the root zone of the sultana vine is comparatively shallow in the river soils. That this is the case with all the important vine varieties grown along the river has been borne out by



on many different soil types. The majority of vine roots feet of the surface, and on some soil types much shallower. es also, with few exceptions, appear to be comparatively ed. The aim in irrigation, then, is to moisten the soil to these roots and to prevent further penetration as much as

cognized that the best method of application of water, and applied, would vary with the soil type; accordingly, where h site is on a different soil type, with an environment that

FIG. 2.—An example of a photostat obtained by the apparatus discussed in the text.

In the bottom left-hand corner, a contact print of the negative from which the photostat was produced, is included.

The low cost of operation and the speed of manipulation are well demonstrated in the following example:—

| | |
|---|---|
| Length of article to be copied. (This necessitated reloading the camera once during the process) .. | 68 pages |
| Time taken in exposing film 68 times, including time occupied in reloading .. .. .. .. | 45 minutes |
| Developing and fixing films .. .. .. .. | 15 " |
| Handling of films, i.e., placing them into wash, and removing them to drying cabinet .. .. | 5 " |
| Enlarging, developing, fixing 68 prints .. .. | 70 " |
| Handling of prints for drying .. .. .. | 15 " |
| Total time— .. .. | 150 minutes or $2\frac{1}{2}$ hours. |

*Cost of Materials.*

| | s. | d. |
|---|---|---|
| Cost of film—10 feet of film at $2\frac{1}{2}$d. per foot .. .. | 2 | 1 |
| Cost of paper—72 whole-plate sheets Bromide B (price £1 0s. 10d. per gross) .. .. .. .. | 10 | 5 |
| Total .. .. .. .. .. | 12 | 6 |
| Labour costs—for $2\frac{1}{2}$ hours—approximately (computed on basis of a twenty year old junior earning £3 per 44 hour week) .. | 4 | 0 |
| Total costs .. .. .. .. .. | 16 | 6 |

Cost per page— .. .. 3d.

The preparation of positive film strips from the negative is a relatively simple procedure and naturally less costly.

It will be seen from this example that the cost of turning out print-copies by such a method as used in the Division of Forest Products is extremely low, even without the refinements of the Bibliofilm Service of Science Service. Equipment similar to that used in the Division could be purchased for £75 to £80. This first cost is not beyond the financial means of many institutions and libraries in Australia, and could soon be recovered if photographic copies of articles were made available to research workers at a cost of, say, 6d. per page for prints $6\frac{1}{2}$ inches x $8\frac{1}{2}$ inches, or 1d. per page for positive film strip. These prices should not be beyond the pocket of the scientific worker. Again, the cost of equipment should easily be offset by the saving on wear and tear of irreplaceable volumes and the reduced likelihood of damage or loss in transit.

There is yet to be developed a suitable and cheap apparatus for producing a large easily readable image of the film without recourse to a projector. Apparently, the design of such an instrument has been completed in the United States but no details are at present available in Australia.

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# Influence of Rice Fields on Local Humidity and Time of Dew Deposition.

*By E. S. West, B.Sc. M.S.,* and H. Mallaby, H.D.A.*†

*Summary.*

Rice fields cause slight decrease in temperature and increase in both relative and absolute humidity during the day time, and increase in relative and absolute humidity and an earlier deposition of dew at night.

This influence is inappreciable beyond the distance of 2 chains from the edge of the rice field.

When the land is wet following recent rain, dew formation is as early as over the rice field.

Cultivation and irrigation of vineyards and orchards influence the time of dew deposition.

A moist soil in the vineyard may cause dew to deposit as early as it does over a rice field.

## 1. Introduction.

On the Murrumbidgee Irrigation Areas, rice fields are frequently located in the vicinity of orchards and vineyards. During most of the summer, the rice is inundated, and it was suggested that the close proximity of these large water areas might be detrimental to orchards or vineyards. In some quarters, it was thought that possible increased humidity or earlier dew formation, acting separately or together, might increase the incidence of fungal diseases or the liability to splitting of grapes of some varieties.

The question was investigated by means of a survey of fungal infestation in vineyards both near to, and distant from, ricefields, and by studying the humidity and time of dew deposition on ricefields and adjacent land. Although a variation in the intensity of fungal attack in different vineyards was apparent, the survey failed to show any association between fungal attack and the proximity of ricefields to vineyards.

This paper deals with the study of the humidity and time of dew deposition which yielded results of interest from a micro-climatic point of view.

These aspects were investigated among other ways by studying the humidity and the time of dew deposition on rice fields and adjacent land. The results of the investigations on humidity and dew formation are reported in this paper; but the authors do not mean to imply that safe deductions as to liability or otherwise to fungal or physiological troubles of vines growing near rice fields can necessarily be drawn from the data.

## 2. Humidity Investigations.

During the 1935-36 summer, the humidity was investigated by sling psychrometer readings taken during the day on a line extending along a check bank within a rice field to a point in the adjacent area well away from the rice field. Humidity determinations were made along

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four lines of this nature, covering a range of conditions outside the rice field. In each line, psychrometer readings were commenced within the rice field and taken at various stations to the other end of the line, and then in reverse order. The mean of the two readings for each station thus compensated for the drift in humidity due to the daily humidity wave. The data obtained for one outward and inward journey will be referred to as one set of readings. Several sets of readings were obtained for each locality investigated.

*Line I.: Rice Field—Vineyard—Prune Orchard.*—Readings were taken in a line extending from a point 5 chains within a rice field on Farm 1592, thence through a vineyard and prune orchard to a point 20 chains from the rice boundary. Eight sets of readings were taken during February and March, 1936. The results are shown in Table 1.†

TABLE 1.

| Station Number. | Description. | Mean Dry Bulb. °F. | Mean Relative Humidity. | Mean Absolute Humidity. |
|---|---|---|---|---|
| 1 | 5 chains within ricefield .. | 81·0 | 56·4 | ·576 |
| 2 | 12 feet without ricefield (road) .. | 82·8 | 51·8 | ·550 |
| 3 | 5 chains without ricefield (in vineyard | 82·9 | 53·6 | ·575 |
| 4 | 10 chains without ricefield (in vineyard) | 82·6 | 53·4 | ·570 |
| 5 | 15 chains without ricefield (in vineyard) | 82·6 | 51·8 | ·555 |
| 6 | 20 chains without ricefield (in prunes) | 82·6 | 50·8 | ·544 |
| z | (1% = ·64 ; 5% = ·46) .. | 1·04 | ·735 | ·304 |
| | Sig. Diff. .. .. .. | ·75 | 2·1 | ·031 |

There is a significant drop in temperature over the rice field and an increase in the relative humidity. There is also a suggestion that the vineyard causes a slight increase in the humidity, though the differences are hardly significant.

*Line II.: Rice Field—Open Unirrigated Land.*—Table 2 summarizes the data from seven sets of readings taken during February and March, 1936. The line of observation extended from within a rice field on Farm 1653 out into open dry country to a distance of 12 chains without the rice field.

A significant drop in temperature and increase in both relative and absolute humidity occurs over the rice field. The extent of the influence of the rice field seems to be detectable about 2 chains from the edge of the field.

† The figures for the absolute humidities refer to the pressure of water vapour in inches of mercury; but it is intended that both these and the relative humidity figures be used mainly for comparisons between themselves.

TABLE 2.

| Station Number. | Description. | Mean Dry Bulb. °F. | Mean Relative Humidity. | Mean Absolute Humidity. |
|---|---|---|---|---|
| 1 | 3 chains within ricefield .. | 78·3 | 54·9 | ·523 |
| 2 | Edge of ricefield .. .. | 79·7 | 51·9 | ·511 |
| 3 | 2 chains without ricefield .. | 80·4 | 48·9 | ·494 |
| 4 | 7 chains without ricefield .. | 80·1 | 47·0 | ·467 |
| 5 | 12 chains without ricefield .. | 80·3 | 47·0 | ·469 |
| z | (1% = ·720; 5% = ·511) .. | 1·46 | 1·44 | ·966 |
| | Sig. Diff. .. .. .. | 0·6 | 2·5 | ·024 |

*Line III.: Rice Field—Open Unirrigated Land—Apricot Orchard—Vineyard.*—Table 3 shows the results of observations extending from within the rice field on Farm 1647 across 18 chains of open dry land and through an apricot orchard and vineyard. The observations were taken during February and March, 1936. Ten sets of readings were taken for stations 1-5; but only four for stations 6-9.

Both the relative and absolute humidities at station No. 1 were greater than at station No. 2, and both were greater at station No. 2 than station No. 3.*

TABLE 3.

| Station Number. | Description. | Mean Dry Bulb. °F. | Mean Relative Humidity. | Mean Absolute Humidity. |
|---|---|---|---|---|
| 1 | 5 chains within ricefield .. | 75·0 | 39·8 | ·330 |
| 2 | Edge of ricefield .. .. | 75·5 | 36·3 | ·310 |
| 3 | 5 chains without ricefield (dry land) | 75·5 | 34·3 | ·290 |
| 4 | 10 chains without ricefield (dry land) | 76·0 | 34·3 | ·293 |
| 5 | 15 chains without ricefield (dry land) | 76·0 | 34·3 | ·285 |
| 6 | 20 chains without ricefield (apricots) | 77·0 | 33·8 | ·290 |
| 7 | 25 chains without ricefield (apples) | 76·3 | 34·5 | ·293 |
| 8 | 30 chains without ricefield (vines) | 76·3 | 37·8 | ·328 |
| 9 | 35 chains without ricefield (vines) | 77·0 | 35·0 | ·305 |
| z | (1% = ·606; 5% = ·428) .. | ·626 | ·63 | ·697 |
| | Sig. Diff. .. .. .. | 1·2 | 3·6 | ·029 |

It is to be noted that the influence of the rice field does not extend to 5 chains without the rice field. There is a strong suggestion that station No. 8 in the vines is more humid than other stations without the rice field. Such local effects as this have been definitely established and are referred to later.

* For convenience of presentation, the data from Table 3 are calculated from the four sets of complete readings. When the data for stations 1–5 are calculated from the 10 sets of readings, the increased precision obtained shows that these differences are definitely significant.

*Line IV.: Rice Field—Road through Orchards.*—The data in Table 4 refer to six sets of readings taken during February, 1936, from a rice field on Farm 1592, and thence for over a mile along a road, bordered by a drainage ditch on one side and a supply lateral on the other. Orchards and vineyards occur on both sides of the road.

There is again a significant fall in temperature and increase in both the relative and absolute humidities over the rice field.

*General Conclusions from Humidity Readings.*

Summarizing the results, the rice fields cause a small but definite decrease in temperature of the order of about 2°F., and an increase in relative humidity of the order of about 6 per cent. under conditions when the relative humidity is in the neighbourhood of 50 per cent. A small increase in the absolute humidity also occurs. These influences do not extend far from the rice field; a slight effect is discernible 2 chains away; but during the day time this seems about the limit of noticeable effects.

TABLE 4.

| Station Number. | Description. | Mean Dry Bulb. °F. | Mean Relative Humidity. | Mean Absolute Humidity. |
|---|---|---|---|---|
| 1 | 5 chains within ricefield .. | 84·3 | 54·8 | ·635 |
| 2 | On edge of ricefield .. .. | 85·6 | 48·6 | ·586 |
| 3 | 3 chains without ricefield (on road) | 87·2 | 45·0 | ·575 |
| 4 | 6 chains without ricefield (on road) | 87·2 | 45·2 | ·568 |
| 5 | 10 chains without ricefield (on road) | 86·8 | 45·3 | ·566 |
| 6 | 20 chains without ricefield (on road) | 86·0 | 45·8 | ·560 |
| 7 | 30 chains without ricefield (on road) | 86·0 | 46·3 | ·572 |
| 8 | 40 chains without ricefield (on road) | 85·8 | 45·8 | ·563 |
| 9 | 60 chains without ricefield (on road) | 87·0 | 45·0 | ·566 |
| 10 | 80 chains without ricefield (on road) | 86·8 | 45·3 | ·570 |
| 11 | 100 chains without ricefield (on road) | 86·8 | 45·6 | ·572 |
| 12 | 105 chains without ricefield (on road) | 86·5 | 44·6 | ·555 |
| z | (1% = ·46; 5% = ·326) .. | ·945 | ·448 | ·96 |
| | Sig. Diff. .. .. .. | 1·0 | 5·7 | ·024 |

## 3. Investigation with Dew Detectors.

The deposition of dew depends on the absolute humidity and the temperature of the cooling body on which the dew condenses. Although the rice field increases the local humidity, one might also expect it to retard the fall in temperature of the surfaces of exposed objects at night, so that it is difficult to argue *a priori* what influence the proximity of rice fields would have on dew deposition.

To study the question directly, standardized "dew detectors" were made. These were sheets of glass (cleaned quarter-plate photographic plates) exposed 1 metre from the ground on stands made from electrical

conduit. The glass was fixed to the stands by means of clips made from No. 12 steel wire. The plate was freely exposed, the wire only touching the glass near the edges. The emulsion was removed from the glass, which was then thoroughly cleansed with ether. By flashing the light of an electric torch on the glass from a distance of several feet, the first deposition of dew could be readily noted. Readings were taken in each locality on several nights, and as a check against any possible idiosyncrasies of the glasses, the plates were frequently changed round from one stand to another at random. The differences in the readings, however, proved consistent. The investigations with the dew detectors were taken during the 1936-37 summer.

*Observations over Rice Fields and Dry Country.*

A line of dew detectors was set up extending from a rice field on Farm 1902 out into open, dry country on Farm 1905, covered with old wheat stubble.

Results of observations made during January and March, 1937, are shown in Table 5.

The rice field significantly affected the absolute and relative humidities and the air temperature. Stations in the rice field or on the edge of the rice field were warmer, had a higher relative humidity, and had a higher absolute humidity than stations removed from the rice field. The greatest change occurred within 3 chains of the edge of the rice field, but the station 11 chains without the rice field was still significantly cooler and less humid than that 6 chains without the rice field. As this refers to one line only, however, too much weight cannot be placed on this last observation, as such differences as these commonly occur within a short distance of one another during the night.

On the 22nd January, 1937, the wheat stubble was wet with recent rain and no difference occurred in the time of dew deposition. On the other three nights, however, dew formed first at the stations within, or at the edge of, the rice field, and progressively later the further was the station from the rice field. The greatest change occurred within 3 chains of the rice field; but some influence seems to have occurred as far as 11 chains from the field.

TABLE 5.

| Station No. | Location. | Mean Dry Bulb Temp. | Mean Relative Humidity. | Mean Absolute Humidity. | Time of Dew Deposition on— 22.1.37. | 23.1.37. | 24.1.37. | 18.3.37. |
|---|---|---|---|---|---|---|---|---|
| 1 | 6 chains within rice.. | 55·2 | 80·9 | ·364 | 9·33 | 13·12 | 13·39 | 15·45 |
| 2 | 3 chains within rice.. | 55·2 | 81·2 | ·368 | 9·34 | 13·13 | 13·40 | 15·46 |
| 3 | Edge of rice .. | 55·1 | 81·0 | ·364 | 9·35 | 13·14 | 13·41 | 15·47 |
| 4 | 3 chains without rice | 54·4 | 76·2 | ·328 | 9·36 | 13·50 | 14·20 | 16·10 |
| 5 | 6 chains without rice | 54·2 | 75·7 | ·323 | 9·37 | 13·51 | 14·22 | 16·11 |
| 6 | 8 chains without rice | .. | .. | .. | .. | .. | .. | 16·18 |
| 7 | 10 chains without rice | .. | .. | .. | .. | .. | .. | 16·20 |
| 8 | 11 chains without rice | 53·8 | 72·1 | ·303 | 9·38 | 13·59 | 14·45 | 16·25 |
| z | (1% value z = ·63) | 1·45 | 1·14 | 1·24 | | | | |
| | Sig. Diff. .. | 0·43 | 3·6 | ·024 | | | | |

*Observations over Rice Field and in Orchard and Vineyard.*

Two parallel lines of dew detectors $1\frac{1}{2}$ chains apart, referred to as line A and line C, were set up in November, 1936, traversing the following:—

South—Rice—thin short oats, 5 chains—road, 1.50 chains—vines, 7 chains—peaches, 5 chains—young citrus.
North (see Fig. 1).

Owing to the apparently anomalous behaviour at station 8A in the vines, additional stations were established on 3rd December, 1936, close to this station, those designated by the letter B being between lines A and C, 8 yards east of line A.

Table 6 summarizes the results of the observations.

On the 2nd November, 1936, the rice land was wet, germinating the rice, but was not covered with water. Dew was deposited at all stations except that on rice land.

TABLE 6.

| Station No. | Distance from Station No. 1. Yards. | Land Occupied by— | Relative Humidity. | Absolute Humidity. | Time of Dew Deposition. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2.11.36. | 4.11.36. | 13.11.36. | 27.11.36. | 27.12.36. | 28.12.36. | 4.1 |
| 1A | .. | Rice | 72·7 | ·359 | Nil | 14·30 | 13·50 | Nil | 9·50 | Nil | 14 |
| 1C | .. | Rice | .. | .. | „ | 14·29 | 13·49 | „ | 9·30 | „ | 14 |
| 2A | 66 | Oats | .. | .. | 13·30 | 14·50 | 14·19 | „ | 14·30 | „ | N |
| 3A | 110 | Oats | .. | .. | 13·30 | 14·51 | 14·27 | „ | 14·31 | „ | „ |
| 3C | 110 | Oats | .. | .. | .. | 14·52 | 14·28 | „ | 14·32 | „ | |
| 4A | 165 | Vines | 79·4 | ·376 | 13·30 | 15·19 | Nil | 15·30 | 10·27 | „ | 14 |
| 4C | 165 | Vines | .. | .. | .. | 15·17 | „ | 16·10 | 10·29 | „ | 14 |
| 5A | 181 | Vines | .. | .. | .. | .. | .. | .. | 9·37 | 15·0 | 13 |
| 6A | 189 | Vines | .. | .. | .. | .. | .. | .. | 9·35 | 15·0 | 12 |
| 7A | 197 | Vines | .. | .. | .. | .. | .. | .. | 9·29 | 15·0 | 12 |
| 8A | 205 | Vines | 84·3 | ·390 | 13·30 | 16·27 | Nil | 15·35* | 9·30 | 15·0 | 12 |
| 8C | 205 | Vines | .. | .. | .. | 16·30 | „ | 15·50* | 9·50 | 15·0 | 12 |
| 9A | 213 | Vines | .. | .. | .. | .. | .. | .. | 9·31 | 15·0 | 12 |
| 9B | 213 | Vines | .. | .. | .. | .. | .. | .. | 9·32 | 15·0 | 12 |
| 10A | 229 | Vines | .. | .. | .. | .. | .. | .. | 9·31 | 15·0 | 12 |
| 10B | 229 | Vines | .. | .. | .. | .. | .. | .. | 9·33 | 15·0 | 12 |
| 11A | 315 | Peaches | 77·0 | ·359 | 13·30 | 16·28 | Nil | Nil | 12·15 | Nil | 13 |
| 11C | 315 | Peaches | .. | .. | .. | 16·29 | „ | „ | 12·20 | „ | 13 |
| 12A | 425 | Citrus | 76·4 | ·357 | .. | 14·54 | „ | „ | 11·30 | „ | 13 |
| 12C | 425 | Citrus | .. | .. | 13·30 | 14·52 | „ | „ | 11·32 | „ | 13 |
| Sig. Diff. | .. | .. | 6·2 | ·026 | Rice land wet | Rice land wet | Water on rice | Vines watered 26th | | | |

* May have been earlier.

On the 4th November, dew was deposited earlier on the rice land than elsewhere. Stations 12A and 12C on the citrus showed early dew deposition, apparently due to the fact that the citrus was cultivated during the day. Turning over the moist soil would cause the night temperature to fall a little faster and possibly would cause an increase in humidity.

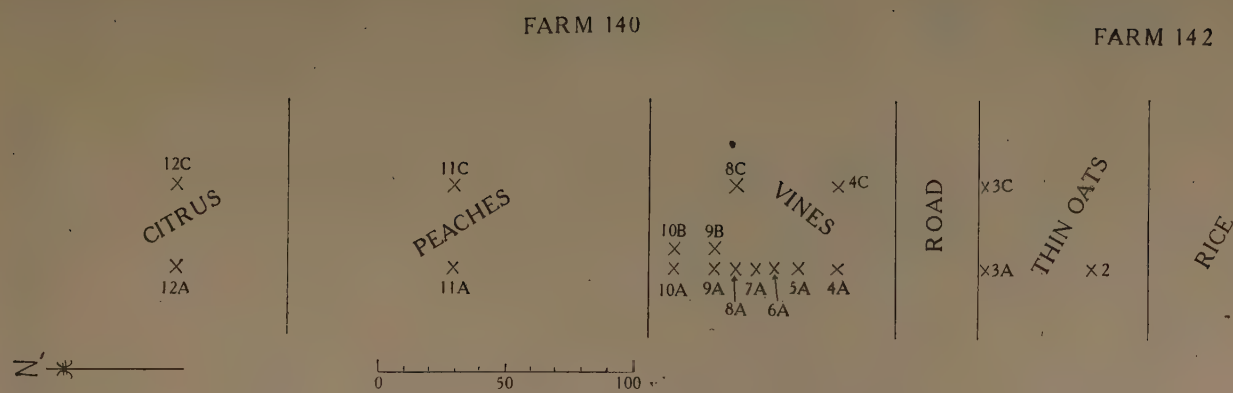


FIG. 1.—Key to location of stations referred to in Table 6.

The data for the 13th November were the first taken after the permanent inundation of the rice field. The influence of the flooding is reflected in the early deposition of dew on the stations in, and near, the field.

The vines were watered on the 26th November. This caused an earlier deposition of dew in the vines than either the rice or the orchard. (See readings on 27th November, 1936.)

On the 7th and 8th December, dew was deposited early on stations 8A and 8C in the vines; * so that further stations were established near these (stations 5A–10B). It will be noticed that these nine stations (5A–10B) are within a rectangle 33 yards by 48 yards.

The observations on the 27th December showed that stations 5A to 10B showed dew depositions as early as those in the rice field and much earlier than all other stations. On the nights of the 28th December, 1936, and the 4th January, 1937, dew deposition was earlier on these stations than all others, including those on the rice.

This early dew deposition is reflected in the mean relative humidity and mean absolute humidities for readings taken on seven nights from the 6th December, 1936, to the 7th January, 1937.

It was noted that the soil in the area occupied by stations 5A to 10B was damper than the rest of the vineyard. Such patches of soil that are usually damper than the rest of an irrigated vineyard are common, and are due to such causes as alteration in grade or soil texture, or other factors which lead to systematic irregularities in watering.

It is interesting to note that the lessee has observed that this portion of the vineyard is the first to be attacked by the downy mildew fungus (*Plasmopara viticola*).

*General Conclusions from Dew Observations.*

When other complicating factors are not present, an inundated rice-field causes an earlier deposition of dew, but the influence beyond 2 chains from the field is inappreciable.

After rain has fallen, dew will be deposited on "dry" country as early as over the rice field.

Even cultivation of the soil may have an important influence on time of dew deposition.

Ordinary orchard and vineyard practices, such as irrigation, may cause dew to deposit as early as it does over a rice field.

The proximity of rice fields does not appear to have an appreciable effect, either on time of dew deposition, or the humidity of neighbouring vineyards or orchards.

Irrigating the vineyard or orchard will have a much greater influence on the humidity and time of dew deposition than the proximity of a rice field.

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* The data for these nights are not shown in the table. Dew was deposited on these two stations early in the night, but no dew was deposited elsewhere. The actual time of dew deposition, however, was not noted.

# Stylosanthes.

*By A. McTaggart, Ph.D.**

The plant genus *Stylosanthes* consists of about 50 known species which are distributed throughout the tropics. Certain species are of special interest to Australia, in that they are of potential value in helping to provide legumes, hence protein, in the pastures of the tropical portions of the country throughout which such a type of plants is scarce. Facts concerning these useful species of *Stylosanthes* are presented in the following discussion.†

The most noteworthy species to date is the so-called wild or Townsville lucerne (*Stylosanthes sundaica,* Taub., syn. *S. mucronata,* Willd.), a native of tropical Asia which was introduced accidentally into north Queensland some time during the early years of the present century. It is a summer-growing, self-regenerating annual which is found distributed throughout the coastal lands lying between Cooktown (and even north thereof) and St. Lawrence, in which territory it has been credited with having been responsible for establishing the dairying industry. The legume is also found widely distributed in the vicinity of Darwin, Northern Territory, where establishment is believed to have taken place at an earlier date than it did in north Queensland. The plant, when grown under favorable conditions, closely resembles ordinary lucerne (*M. sativa*). Its habit of growth, however, is almost invariably decumbent or prostrate, and it forms, especially when closely grazed, a dense green mat of much branched fine stems and very numerous, elongated, narrow, and acute leaves. It is reputed to be readily grazed by stock when it is drying off in the autumn and to be less palatable when in full bloom, although comparing favorably with ordinary lucerne in nutritive value in so far as such quality can be revealed by chemical analysis. A summer grower, it requires an abundant summer (monsoonal) rainfall. Its growth in north Queensland has shown it to be well adapted to light, sandy, coastal-plain soils. In those areas of sub-tropical to tropical Australia where, owing to soil and climatic disadvantages, better pasture legumes will not thrive, *Stylosanthes sundaica* has a definite place, as has been already amply demonstrated. The selection and distribution of an upright type of "wild lucerne" would enable forage therefrom to be gathered as hay and used in this form for completing the production of fat cattle in North Australia. Selection of an early-maturing strain from the numerous variable plants which are available would probably favour its wider culture, particularly in districts located at higher elevations which experience a shorter season, but only under conditions unfavorable for the growth of better legumes such as lucerne and various species of *Trifolium.* The selection and propagation of improved types of *S. sundaica,* including the upright hay type above referred to, for culture in the existing "wild lucerne" area are further possibilities.

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† As this is a compilation to which many observers have contributed, in various ways, formal acknowledgment herein would be somewhat cumbersome.

Encouraged by the success of the annual *Stylosanthes sundaica* in improving or providing pasture in the coastal areas of north Queensland, the Division of Plant Industry sought by correspondence overseas, a perennial species of *Stylosanthes* which in tropical Australia might prove to be a true substitute for lucerne (*M. sativa*) as a pasture legume. The search resulted in the introduction, on 4th October, 1933, of the perennial species *Stylosanthes guyannensis* Sw. (vernacular name "Trifolio") (C.P.I. 5630)* from Brazil. Seed was at once sent to the Queensland Agricultural College for trial in the plant introduction garden established and maintained there by the Council in co-operation with the College. In light soil located there, the legume grew successfully, and from the start gave promise of becoming another useful legume for pasture purposes in Queensland, especially in north Queensland. Subsequent culture at the College and at the new Plant Introduction Station established at Fitzroy Vale, Rockhampton, supported the early favorable opinion formed with regard to it.

*S. guyannensis* is a native of sandy loams in Brazil, where it has proved valuable for pasture or hay and where its nutritive value has been shown to be fully equal to that of lucerne. Its dense, spreading mass of heavily-leaved, fine, decumbent stems is produced continuously throughout the growing season, even during the dry period usually experienced during autumn. The abundant leaves are trifoliate, narrow, acute, and elongate (1 to 2 inches long). Its stems are covered with short soft hairs. The sheaths are red, and the flowers are small and borne in clusters at the upper nodes of the stems. Each cluster consists of 10 to 15 flowers, and each pod carries a single dark brown seed. Flowering occurs late in the season, usually towards the end of May. On sandy loam soils, to which it is primarily adapted, it produces a fair quantity of seed, which usually has to be collected from the ground during the winter, as in the case of *S. sundaica*. Being a tropical plant, it is readily injured by frost. Consequently, its culture should be confined to localities where frost does not occur or where killing frosts are never experienced. In the northern pastoral areas where frost is unknown, especially on the lighter soils of such regions, this plant in due course should prove a valuable addition to the existing herbage. The fact that it is a perennial, and is thus independent of the necessity for regeneration annually from seed, together with its ability to continue to grow during dry periods of a few months duration, are qualities which should make this legume specially welcome in the areas mentioned.

A variety of the afore-mentioned species which was introduced by the Council at the same time (4th October, 1933) from Brazil is *Stylosanthes guyannensis*, Sw. var. *subriscosus* (vernacular name in South America "Meladinho") (C.P.I. 5631). Its dense growth is more prostrate than that of the species previously described, and its stems are finer. The numerous leaves are 1½ inches long, narrow, and densely pubescent, which latter character gives a greyish tinge to the normally green foliage. A sticky excretion from these short soft hairs is characteristic of the variety. Its yielding capacity is slightly lower than that of *S. guyannensis*. Further tests, under frost-free conditions, will doubtless establish its claim to be regarded as an additional legume of potential value for northern pastoral areas.

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* C.P.I. = Commonwealth Plant Introduction.

Another species of *Stylosanthes* which was introduced by the Council —in July, 1935, from the Bahamas, West Indies—is *Stylosanthes procumbens,* Sw. (C.P.I. 6164). This is a procumbent or semi-prostrate, rather open, perennial species with stems which are woody at the base, leaves which are abundant and pinnately-trifoliate, and small yellow flowers which are borne in the axils of the leaves. The plant is usually regarded as being a variety of *Stylosanthes hamata,* L., from which it differs principally in habit of growth, *S. procumbens* being more prostrate. Like the species previously described, it has potential value as a useful pasture legume in sub-tropical to tropical Australia. The plant is undergoing further investigation at the Council's plant introduction stations in Queensland.

The foregoing discussion provides a vista of possible development with an exotic plant genus which is new, or relatively new, to Australia, and which, because of its potentialities, bids fair to earn it the title of "the lucerne of the North."

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# Yield and Quality in the Zante Currant with Special Reference to Cincturing and Tipping.

*By J. E. Thomas, B.Sc., B.Agr.Sc., B.V.Sc.**

*Summary.*

From the results of experimental work with the Zante currant vine grown under Mildura conditions, it is concluded:—

(1) Although an improvement in grade is obtained by reducing the number of bunches below that normally resulting from winter pruning, the loss in yield does not make this method economically practicable under present conditions.

(2) The development of the characteristic black pigment is closely related to the sugar content, and is not influenced by the use of iron.

(3) Late cincturing usually results in a reduced yield, accompanied by a slight increase in grade. The optimum results may be expected from cincture ⅛-in. wide, applied when approximately 60 to 80 per cent. of the caps have fallen from the flowers.

(4) Tipping the growing shoots at this period appears to be beneficial, and particularly so if the time of cincturing is delayed. On the other hand, tipping or topping later in the season is deleterious.

(5) From general considerations, tipping may be of especial value in years when cool cloudy weather conditions prevail, or if there is exceptionally rapid growth of the shoots at the time of flowering.

## 1. Introduction.

Although the average yield of the Zante currant in the Mildura district is high, the quality of the dried product is definitely inferior to that produced in Greece. The local sample is usually smaller in size, with a higher percentage of small red berries, and is heterogenous both in size and pigment development. The premium paid for quality within

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* An officer of the Commonwealth Research Station, Merbein.

the grades of the Australian currant has not been high enough to warrant an increase in quality, if accompanied by much loss of crop.*

While various proposals for increasing the quality of the currant crop have been put forward, considerable uncertainty exists regarding the best methods of obtaining good quality and still maintaining yield. Some of these proposals are discussed below. In addition, since it is known that the operations of cincturing and tipping affect both yield and grade, a somewhat fuller enquiry of these practices was made.

## 2. Bunch Restriction.

Restriction of bunches, either by severe winter pruning or by ordinary pruning followed by a partial disbunching early in the season, would appear to be one obvious way of raising the quality of the dried fruit.

In the spur-pruned Zante currant, the bunches may be borne either on shoots arising from spurs or on adventitious shoots erupting from the older wood. Lyon (2) has shown that there is a fairly close relationship between the vigor of the shoot and the size and maturity of the bunch which it carries. The vigorous shoots have larger bunches, which mature earlier than those on weaker shoots, many of which are of adventitious origin. The latter tend to flower late and irregularly, and at harvest time the fruit has a low sugar content (see Table 2). On drying, there is a large proportion of small, red, shrivelled berries. If disbunching is practised, it would appear desirable that this type of bunch should first be removed. This is effected by removal of the adventitious shoots (disbudding) at an early stage, usually in October.

The results of two experiments on vines, pruned in the ordinary way in the winter, are given in Table 1. In the first experiment, all the adventitious shoots were removed (disbudded) in October. In the second, approximately 25 per cent. of the total number of bunches were removed, but the partial disbunching was confined to those borne on spurs only.

In the first experiment, the increase in weight of the bunches on the disbudded vines was not considerable, and did not compensate for the loss of the adventitious bunches. The grade was slightly increased, but the final result was a substantial decrease in yield.

The second experiment confirmed these results. The loss of a proportion of the better developed bunches on the spurs very materially reduced the yield of fresh fruit. If allowance is made for the relative weights and proportions of the two types of bunch, it would appear that the increase in the mean dried weight of the bunches remaining was not considerable. The sugar content of the juice was substantially increased and the grade was raised, but this gain was not equivalent to the monetary loss involved by the loss of crop. Under present conditions, crop restriction along these lines does not appear to be economically practicable.

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* During the period 1931-35, the average nett realizations per ton of the different grades were as follows:—1 crown, £26 2s.; 2B, £28; 2A, £28 9s.; 3B, £30 4s.; and 3A, £31.

TABLE 1.—PARTIAL DISBUNCHING EXPERIMENTS.*

| Treatment. | Number of Bunches. | Mean Weight of †Fresh Bunch. | Mean Specific Gravity of Juice. Degrees Baumé. | Mean Weight of Fresh Fruit. | Estimated Dry Yield. |
|---|---|---|---|---|---|
| | | *No.* 1 ($n$ = 20). | | | |
| | | lb. | | lb. | % |
| Control ($a$) .. | Adventitious 74 | ·27 | .. | 57·8 | 100 (2B) |
| | On spurs 78 .. | ·51 | | | |
| Disbudded ($b$).. | On spurs 64 .. | ·53 | .. | 36·6 $a > b$ | 70–75 (2A) |
| | | † Twelve vines only. | | | |
| | | *No.* 2 ($n$ = 24). | | | |
| Control ($a$) .. | Total 125 .. | .. | 12·1 | 26·2 | 100 (2B) |
| Partially disbunched ($b$) | Total 95 .. | .. | 14·6 $b > a$ | 14·5 $a > b$ | 74 (3A) |

* In the experiments recorded, single vine plots were used, set out at random within blocks, and the results examined by the analysis of variance. N equals the number of replications. ($a > b$) indicates that "$a$" is significantly greater than "$b$".

It is now recognized that in order to avoid the loss of crop by disbudding, it is necessary to provide for additional spurs at the previous winter's pruning in order to compensate for the crop which is later removed. When this is done, disbudding is not accompanied by a nett reduction in number of bunches, and offers promise as one method for securing a more even type of fruit. The whole practice is being separately investigated, and will not be discussed further at this stage.

### 3. Use of Iron Salts.

The relation between the appearance of the fruit and the sugar content is illustrated by the results from two sites A and B (Table 2). Each figure is the average of six determinations.

TABLE 2.

| Site. | Colour of Fruit. | Gravity of Juice. Degrees Baumé. | Acidity of Juice. Gms. Tartaric Acid per Litre. |
|---|---|---|---|
| A. (19.2.34) .. | Green .. .. .. | 9·0 | |
| | Red-green .. .. .. | 9·6 | |
| | Black .. .. .. .. | 14·2 | |
| B. (19.2.34) .. | Red-green* .. .. .. | 8·8 | 9·2 |
| | Black .. .. .. .. | 15·1 | 8·4 |
| B. (19.2.35) .. | All green .. .. .. .. | 9·4 | |
| | Mainly green .. .. .. | 11·4 | |
| | Cinctured—partly black .. .. | 12·8 | |
| | Non-cinctured, deep black, probably wilted | 17·0 | |

* On adventitious shoots.

Sugar content and pigment development appear to be normally associated in maturation of the fruit. However, it has been suggested that the development of the black pigment might possibly be accelerated by the use of iron salts, even in the absence of any symptoms suggestive of an iron deficiency. Although lime-induced chlorosis is a well known condition, particularly in some American vines, and notably so in *Vitis riparia*, it has not yet been recognized in the Zante currant in the Mildura area, even when grown on highly calcareous soils. Chlorotic symptoms are almost invariably associated with excessive soil salinity or waterlogging (Thomas (5)).

The question was experimentally investigated by direct injection of iron salts in order to eliminate the possibility of the unavailability of soil iron.

The details of the experiment were as follows:—On a calcareous mallee soil containing about 20 per cent. calcium carbonate (pH approximately 9.2), fifteen vines were injected on the 7th February, 1935, with a 0.25 per cent. solution of ferrous sulphate, according to the technique of Thomas and Roach (6). Various amounts were absorbed, and slight defoliation was noted in those in which the amount exceeded 2.0 litres. Only those receiving less than 1.5 litres and showing no manifest injury were retained in the experiment. At the following harvest, the vines were individually harvested and examined. The type of fruit was indistinguishable from that on the control vines, which carried a large crop of low-grade fruit. Similar results were obtained on other vines in which crystals of ferrous sulphate had been placed in holes bored in the trunk earlier in the season. The injection of iron salts, therefore, does not appear to influence pigment development.

## 4. Cincturing and Tipping.

### (*a*) *Times and Methods.*

Since its introduction from Greece into Australia by Catton Grasby, in 1897, flower-time cincturing of the Zante currant has been universally adopted as the method for preventing "coulure"*. Seedlessness is an important commercial characteristic of this variety, and Pearson (4) has shown that the almost complete parthenocarpy observed is due to defective embryo sac development. The status of pollination is still obscure. The nutritional effect of ringing is essential in order to ensure berry development.†

Early fears that this practice might adversely affect vegetative vigour have not been realized, provided that it is carefully carried out on mature vines. Further, the ease with which a currant vine can be reconstituted makes the problem a relatively minor one.

The cincture is made on the trunk, and consists of the removal of a circle of bark the width of which depends very much upon the personal views of the operator. Probably $\frac{1}{8}$-in. may be an average value. The cut, which heals over with callus tissue, should be just sufficiently wide

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* Coulure may be taken to include excessive flower drop beyond the normal 70 to 80 per cent., abortion of berries or failure to develop beyond a very immature stage. Excessive flower drop is, however, much more important.

† It has been recently shown that the stimulus of pollination and the nutritional effect of ringing are both necessary to obtain a satisfactory set of fruit. (Olms, H. P.—*Proc. Amer. Soc. Hort. Sc.*, **34**: 402, 1936.)

to limit the effect of the cincture to this critical period only. Essentially, a ring of phloem is removed, injury to the xylem being carefully avoided. The time of cincturing is usually expressed in terms of the estimated percentage of caps or opercula which have fallen. There is a period of about four days only from the falling of the operculum to the small shot berry stage, but on the one vine this time may extend over twelve days. This is due to the variation in the flowering times of the different inflorescences, and particularly those borne on adventitious shoots (loc. cit.). In addition to cincturing, tipping or removal of the growing tips of the shoots may be practised, either just before, or after cincturing.

These two treatments were experimentally investigated; the results are given in Table 3.

TABLE 3.—EFFECT OF CINCTURING AND TIPPING ($n = 24$).

| Treatment. | Yield of Fresh Fruit. | Drying Ratio. | Grade. | Mean Berry Weight. (1). |
|---|---|---|---|---|
| | lb. | | | |
| Control (not treated) ($a$) .... | 21·6 | 2·93 | 3B | 105 mgms. (C.V. = 33% (2) |
| Cinctured only ($b$) .. .. | 41·0 | 3·80 | 2B | 131 (C.V. = 50%) |
| Tipped only ($c$) .. .. | 25·2 | 3·00 | 2B | |
| | ($b > c > a$) | | | |

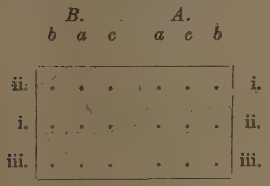
(1) Mean of 100 berries when dried. (2) Coefficient of variability.

Both treatments significantly increased yields, cincturing much more so than tipping. The characteristic features of the fruit from uncinctured vines were as follows:—

(i) Poor setting, i.e., small number of berries per bunch, the prime factor in the reduced yield;
(ii) Lower, but more uniform, berry size;
(iii) Advanced maturity (*vide* drying ratio); and
(iv) Better development of pigment.

The nett effect of (iii) and (iv) is expressed in the rise in crown grading.

The methods and times of cincturing and tipping have also been investigated by means of a complex experiment in 1936-37, and a series of minor experiments during 1931-35. For the former, an area of 270 vines was selected and laid out in plots of nine vines, as below. The following treatments were applied at random:—




*Plan of one block.*

Major: $A$. Tipped 28th Oct.
$B$. Not tipped.

*Width of Cincture.*

Minor: $a$—Single knife cut.
$b$—Cut approx. $\frac{1}{8}''$ wide.
$c$—Cut approx. $\frac{1}{4}''$ wide.

*Time of Cincture.*

Minor: i.—28th Oct.—no caps fallen.
ii.—5th Nov.—70 per cent. caps fallen.
iii.—13th Nov.—berries small shot size.

The vines were individually tray dried.

The results of the analysis of variance are given below.

*Experiment No. 1.*

*Mean Dried Weights (lb.).*

| | A. | B. | |
|---|---|---|---|
| a .. | 11·98 | 11·33 | 11·66 |
| b .. | 13·38 | 12·06 | 12·72 |
| c .. | 12·86 | 12·13 | 12·50 |
| i. .. | 12·55 | 11·79 | 12·17 |
| ii. .. | 13·15 | 12·52 | 12·84 |
| iii. .. | 12·52 | 11·21 | 11·87 |
| | 12·74 | 11·84 | |

**All treatments and interaction of *A* and *B* with *a*, *b*, and *c* were significant.***

*Order of Significance.*

| | |
|---|---|
| $A > B$ | (S.E.d = ·210 lb.) |
| $b > a$ | (S.E.d = ·157 lb.) |
| ii. > i.<br>ii. > iii. | (S.E.d = ·300 lb.) |

* In Experiment No. 1, the interaction of tipping with time of cincturing is probably real, and the statistical non-significance may be due to the higher standard errors of the minor plots *a*, *b*, *c* (.157 lb.).

A careful grading of the different treatments was made, but no outstanding differences were evident. The early cinctured fruit had usually a higher percentage of red berries than the late cinctured, but this was to a considerable extent offset by the larger berry size.

The results of the minor experiments are set out in Table 4.

The general conclusions from these experiments may be summarized as follows:—

(i) Late cincturing (1, 2, 3, 8)—when the berries are in the small shot stage—is invariably associated with small bunch weights, reduced yield, earlier ripening, and slightly improved quality. In general, the type of fruit produced tended to approach that on uncinctured vines. The improved quality did not compensate for the decline in yield. In considering early ripening, the question of rain damage in January and early February has to be considered. Owing to their higher osmotic pressure, there is a pronounced tendency for the more mature berries to split badly after rain, which may lead to mould infection, premature desiccation, dropping of the berries before harvest, and generally result in a loss both of yield and grade. During the past few seasons, the incidence of rain in this period has been the dominant factor controlling grade. The advantages of early ripening are therefore somewhat problematical.

(ii) Cincturing in the pre-flowering stage resulted in lower yields. The optimum results were obtained with a cincture ⅛-in. wide applied when from 70 to 80 per cent. of the caps had fallen.

(iii) Tipping was of benefit in nearly all cases (1, 2, 3, 4, 5, 8), particularly so when late cincturing was practised, and also with the ⅛-in. cincture (see Treatment *Ab*, Expt. 1). A preliminary tipping would be particularly advantageous in cases when the cincturing extends over several days.

TABLE 4.—SUMMARY OF CINCTURING AND TIPPING EXPERIMENTS (1931-35).

| Treatment. | Mean Yield of Fresh Fruit. | Mean Bunch Weight. | Mean Dry Weight. | Gravity of Juice. Degrees Baumé. |
|---|---|---|---|---|
| *Experiment No. 2.* ($n = 25$.) | | | | |
| Tipped 7th, Cinct. 12.11.31 (*a*) | 28·0 | .. | .. | .. |
| Not tipped, „ „ (*b*) | 24·8 | .. | .. | .. |
| „ „ 21.11.31 (*c*) | 18·1 | .. | .. | .. |
| (All caps fallen 9th, berries well advanced 21st Nov.) | ($a > b > c$) | | | |
| *Experiment No. 3.* ($n = 28$.) | | | | |
| Tipped 12th, Cinct. 18.11.32 (*a*) | 29·4 | ·186 | .. | 14·1 |
| „ „ „ 26.11.32 (*b*) | 13·1 | ·089 | .. | 16·1* |
| Not tipped, „ „ (*c*) | 16·7 | ·120 | .. | 16·2* |
| „ „ 18.11.32 (*d*) | 29·1 | ·183 | .. | 14·0 |
| (All caps fallen 12th, berries well advanced 26th) | ($a=d>c>b$) (1) | ($a=d>c>b$) | | * wilted ($b=c>a=d$) |
| *Experiment No. 4.* ($n = 25$.) | | | | |
| Tipped 1st, Cinct. 8.11.33 (*a*) | 61·0 | ·294 | .. | 13·00 |
| Not tipped, „ „ (*b*) | 53·0 | ·258 | .. | 13·35 |
| (All caps fallen 9th Nov.) | ($a > b$) (2) | | | |
| *Experiment No. 5.* ($n = 35$.) | | | | |
| Tipped 10th, Cinct. 19.11.33 (*a*) | .. | .. | 3·65 | .. |
| Not tipped, „ „ (*b*) | .. | .. | 3·05 | .. |
| (All caps fallen 8th Nov.) | | | ($a > b$) | |
| (*Experiment No. 6.* ($n = 18$.) | | | | |
| Cinctured 1.11.34 (*a*) .. | 42·1 | .. | 11·90 (2B) | .. |
| „ 8.11.34 (*b*) .. | 45·7 | .. | 11·30 (2B) | .. |
| (Nov. 7th, all caps fallen. Cloudy and dull flowering period) | (N.S.) | | (N.S.) | |
| (*Experiment No. 7.* ($n = 24$.) | | | | |
| Cinctured 7.11.34 (*a*) .. | 52·4 | .. | 12·41 (2B) | .. |
| „ 11.11.34 (*b*) .. | 48·9 | .. | 12·75 (2B) | .. |
| | (N.S.) | | (N.S.) | |
| *Experiment No. 8.* ($n = 30$.) | | | | |
| | | | | (15.1.35) |
| Cinctured 30.10.34 (*a*) .. | 30·3 | .. | 9·75 (2B) | 10·18 |
| „ 4.11.34 (*b*) .. | 31·2 | .. | 10·10 (2B) | 10·50 |
| „ 9.11.34 (*c*) .. | 26·3 | .. | 9·20 (2A) | 11·10 |
| (Caps commenced to fall 30th Oct., 80 per cent. fallen 4th Nov., berries small shot size 11th Nov.) | ($a = b > c$) | | ($a = b > c$) | ($c > b = a$) |

N.S. Not significant.
(1) Calculated dry weights considered in same order of significance.
(2) Difference of calculated dry weights of doubtful significance.

An investigation was also made of the effects of topping when applied later in the season. The practice of severe tipping or topping is often carried out on the assumption that the admission of sunlight is desirable to hasten pigment development in the berry. This was not supported in some preliminary experiments with shoots which were defoliated in the ripening period. The berries wilted and remained red. Other bunches enclosed in light-proof bags appeared to colour up just as well as those outside.

In addition, an experiment, the results of which are shown in Table 5, was carried out.

TABLE 5.—EFFECT OF LATE SEASON TOPPING ($n = 30$).

| Treatment. | Mean Yield of Fresh Fruit. | Mean Dry Weight. |
|---|---|---|
| | lb. | lb. |
| Control—untopped (*a*) .. .. .. | 89·6 | 22·4 (2B) |
| Topped late December, tipped middle January (*b*) | 78·8 | 20·3 (2B) |
| | ($a > b$) | ($a > b$) |

The effect of this treatment was to depress yields significantly without influencing quality. Topping at this time of the year results in a reduction in leaf area, and delays maturation, probably explaining the loss in yield above. It has already been shown that increase in sugar content and pigment development are closely related. Hence there are some grounds for predicting that the effect of this treatment would be rather to retard than accelerate pigment development. The practice therefore can be considered definitely deleterious.

(*b*) *Influence of Climatic and Other Factors.*

It is now fairly well recognized that climatic and other factors—excluding those mechanically affecting setting—may considerably control the incidence of coulure and also the efficiency of cincturing and tipping. Coulure is more in evidence when cool cloudy weather conditions prevail during the flowering period.

At Anapa in the Black Sea region, Merjanian, working with wine varieties (3), has shown that the development of coulure tissue—a large celled special tissue separating the pedical from the rachis of the inflorescence—is assisted by the following factors, all of which are probably interdependent:—

- (i) faulty fertilization;
- (ii) delayed seed development;
- (iii) cool and humid weather during the flowering period; and
- (iv) reduced supply of photosynthetic material to the berry and seed—in many cases due to the competition of the growing tip.

In California, Winkler (7) has shown that the berry set of the Muscat of Alexandria* is definitely associated with an increased amount of sugars (both percentage and total) in the shoots and inflorescences. This evidence suggests that the carbohydrate supply to the developing bunch is the prime factor controlling coulure.

In the Zante currant, some experimental evidence in support of this has also been obtained. In 1934, a number of vigorous vines were left uncinctured and inflorescences were selected from cinctured and uncinctured vines. They were rapidly removed to the laboratory, dipped in boiling alkaline alcohol, dried in vacuo at 60° C., ground,

* The Gordo Blanco of Australia is probably identical with this variety.

and examined for reducing and total sugars. The means of six determinations were—

| | Cinctured. | Uncinctured. |
|---|---|---|
| Reducing sugars .. | 5.7 .. | 5.5% of dry wt. |
| Total sugars .. | 7.0 .. | 6.1% of dry wt. |

The differences, although suggestive, were just below the level of significance.

In his monograph, Curtis (1) claims that the phloem is the main conducting path for carbohydrate, and under normal conditions, for nitrogen also. This latter claim is still in dispute, but there is fairly general unanimity that the phloem cincture cuts off the migration of soluble carbohydrates to the roots resulting in a temporary accumulation in the annual wood and shoots.

In the second experiment, the tips of 20 shoots on an uncinctured vine were removed and a 0.50 per cent. solution of glucose injected through the cut tip by gravity from an overhead container. The solution was changed daily and approximately 30 mls. per day per shoot were absorbed over the flowering period of twelve days. The same number of shoots were injected with water only. There was a slightly better set of berries on the glucose-injected shoots.

Removal of the growing tip, just at the time of opening of the inflorescence, might be expected to make available a greater supply of carbohydrate for the developing bunch. Further, if the rate of growth of the shoots is excessive—for example, under conditions of abundant soil moisture and nitrogen supply—the necessity for tipping might be expected to be correspondingly greater. During cool cloudy weather, there would be reduced photosynthesis and temporary growth restraint by tipping would again appear desirable.

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# Lucerne Culture: Introduced Varieties Compared in Yield with the Standard Variety (Hunter River) under F. C. T. Conditions.

*By A. McTaggart, Ph. D.**

## 1. Introduction.

The introduction of new varieties of crops demands comparison with standard varieties so that their worth can be determined for a given environment. With this object in view, the tests described below were initiated and systematically conducted over a period of five years from the date of seeding.

## 2. Description of Tests.

On 5th April, 1932, and 15th August, 1932, respectively, there were seeded, on level land consisting of reddish clay loam soil on the Duntroon (F.C.T.) Farm of the Division of Plant Industry, two series of hundredth acre replicated plots embodying various introduced varieties of lucerne, in comparison with the standard variety—Hunter River. The triplicated plots, 100 links x 10 links, were seeded at the rate of 10 lb. per acre and were provided with suitable border seedlings. The soil was well cultivated and manured with superphosphate at the rate of 2 cwt. per acre. Though the surface soil had the same general appearance throughout, it apparently varied somewhat in productivity for lucerne, due possibly to variation in the physical condition of the subsoil, which fact is reflected in the higher average yields of the crop obtained from the Test II. area as compared with those harvested from the Test I. area. The check (Hunter River) occupied every fifth plot in Test I. and every third plot in Test II. The varieties compared included the following:—In Test I.—Hunter River (check), Calchaqui (C.P.I. No. 2610), Ladak (C.P.I. No. 1056), Hairy Peruvian (C.P.I. No. 1353), Arizona Common (C.P.I. No. 1354), and Argentine (C.P.I. No. 1352); in Test II.—Hunter River (check), Cape (C.P.I. No. 2699), and Chinese (C.P.I. No. 2700).

## 3. Technique Employed.

In each of the four seasons (1933-1937) during which yield data were obtained, four cuttings were made from all varieties with the exception of Ladak, which provided only three cuttings. The technique adopted for obtaining yields from the two series of plots was as follows: A metre-square half-inch wooden frame was thrown at random four times over each plot, care being taken to avoid taking cuttings from the spots used for the previous sampling. The growth of lucerne, at approaching full bloom stage, was cut rather closely from within each square, and the cut material was carefully collected and air-dried for a period in sugar bags suspended in an airy place and in the open. The average of the four cuttings gave the yield of air-dried lucerne per square

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metre. From these data, the yields per acre were calculated. In Table I. are included the yields per acre and the relative yields, calculated on the basis of 100 for the check, a comparison of which reveals the standing of each variety in the tests.

TABLE I.—RESULTS OF LUCERNE VARIETY TRIALS CONDUCTED ON DUNTROON (F.C.T.) FARM DURING PERIOD 1932-1937.

| Variety. | Total Average Yield, in Grams Per Square Metre of Air-Dried Forage, from Four Cuttings. | | | | Average Total Annual Yield, in Grams Per Square Metre of Air-Dried Forage, for 4-Year Period 1933–37. | Average Total Annual Yield of Air-Dried Forage in Tons Per Acre (for Period 1933–37). | | Relative Yield (on Basis of 100 for the Check). |
|---|---|---|---|---|---|---|---|---|
| | 1933–34 Season. | 1934–35 Season. | 1935–36 Season. | 1936–37 Season. | | | | |
| *Test I.* | | | | | | tons | lb. | |
| Hunter River (check) .. | 338·7 | 606·875 | 324·81 | 288·875 | 389·815 | 1 | 1239·2 | 100·0 |
| Calehaqui .. | 287·5 | 500·0 | 327·33 | 225·08 | 334·97 | 1 | 749·7 | 85·9 |
| Ladak ... | 208·5 | 336·66 | 175·8 | 136·41 | 214·34 | 0 | 1913·0 | 54·9 |
| Hairy Peruvian | 421·2 | 602·5 | 383·525 | 326·75 | 433·49 | 1 | 1629·0 | 111·2 |
| Arizona Common .. | 345·0 | 590·0 | 368·75 | 320·56 | 406·077 | 1 | 1384·3 | 104·17 |
| Argentine .. | 315·0 | 487·5 | 245·125 | 204·75 | 313·09 | 1 | 554·4 | 80·3 |
| *Test II.* | | | | | | | | |
| Hunter River (check) .. | 427·5 | 1085·0 | 581·575 | 461·5 | 638·89 | 2 | 1222·2 | 100·0 |
| Cape .. | 363·3 | 1035·8 | 541·45 | 418·125 | 589·668 | 2 | 782·9 | 92·29 |
| Chinese .. | 431·7 | 1135·0 | 563·66 | 448·33 | 644·67 | 2 | 1273·8 | 100·9 |

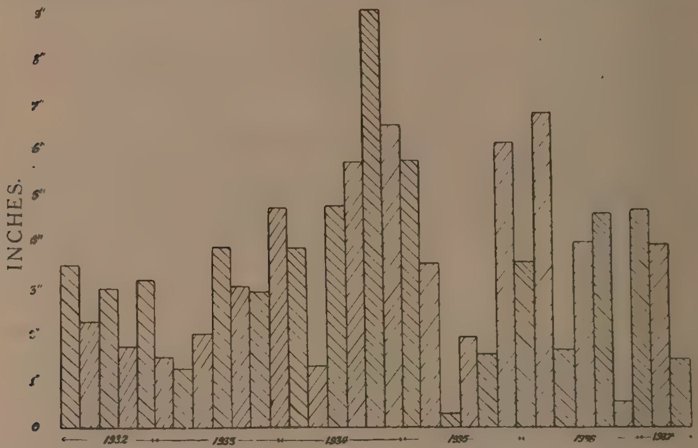
## 4. Results of Tests.

A perusal of the figures in Test I. shows at a glance definite superiority in yield of the Hairy Peruvian variety in comparison with the Hunter River variety (check). The capacity of the Arizona Common variety to out-yield the check is not so pronounced. Thus it can only be claimed for the latter variety that it is at least the equal in yield of the Hunter River variety. The same finding can be arrived at with respect to the Chinese variety, following a perusal of the final figures given under Test II. Thus the yielding capacity of the various varieties, based on the results herein revealed, causes them to be arranged in the following order:—

1. Hairy Peruvian.
2. Arizona Common.
   Chinese.
   Hunter River.
3. Cape.
4. Calehaqui.
5. Argentine.
6. Ladak.

The manner in which the yielding capacity of the varieties included in Test II., and to a lesser extent of the Arizona Common and Hairy Peruvian varieties in Test I., is maintained is also an observation which might be recorded here. The marked variation in the seasonal yields is

for the most part correlated with seasonal variation in rainfall, as is indicated in the accompanying histogram graphically representing the precipitation experienced over the period during which the tests were conducted.




Rainfall at Duntroon, F.C.T., 30th March, 1932, to 30th April, 1937, by 8-weekly periods.

## 5. Some Particulars Concerning the Varieties Tested.

The seed used for the check represented commercial seed of the Australian standard variety Hunter River. As far as was known, this seed was representative of ordinary purchasable seed of this variety and not that of seed which had undergone improvement by selection.

Calchaqui (C.P.I. 2610) was a variety which originated in Salta Province, Northern Argentina, and which was introduced from that country by the Division in August, 1931.

Ladak (C.P.I. 1056) was a variety which, as F.C.I. 15988, was introduced by the Division from the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D.C., in October, 1929. It originated in the northern mountains of British India, and has since been recommended for culture only in regions where the growth period is short and dry, for it regenerates slowly following cutting.

Hairy Peruvian (C.P.I. 1353) was a variety which, as F.C. 15836, was received from the U. S. Bureau of Plant Industry, Washington, D.C., in May, 1930. It came originally from Peru, and is noted for its long, in some parts almost continuous, growing season and its great regenerating capacity, which characteristics cause it to be regarded in favourable locations as a good winter lucerne.

Arizona Common (C.P.I. 1354) was a variety which, as F.C. 15837, was received from the U. S. Bureau of Plant Industry, Washington, D.C., in May, 1930. Its name indicates its origin in the south-west of the United States.

Argentine (C.P.I. 1352) was a variety which, as F.C. 15996, was also received from the U. S. Bureau of Plant Industry, Washington, D.C., in May, 1930. As its name indicates, it came originally from Argentina.

Cape (C.P.I. 2699) was a variety which was received in 1931 from Cape Province, South Africa. This variety had its origin in the Province lucerne which was imported from France and which, however, is now reputed to differ morphologically and physiologically from its descendant.

Chinese (C.P.I. 2700) was a variety which also was received in 1931 from Cape Province, South Africa. It was discovered by David Fairchild, Plant Explorer, U. S. Department of Agriculture, in the mountains of the Tibetan frontier, introduced into arable farming in Western United States, and eventually introduced into South Africa. There it has a long growing season, is cold-resisting and good yielding, grows on slopes and high levels, thrives on saline soils, and in the humid coastal area is more widely grown to-day than the Hunter River variety.

## 6. Acknowledgments.

For the systematically arranged rainfall data at Duntroon (F.C.T.) Farm, from which the accompanying histogram was drawn, I am indebted to Miss F. E. Allan, M.A., Biometrician. In the securing of the data herein reported, I also acknowledge the assistance rendered by various co-workers, including W. Hartley, B.A., and J. A. Redpath.

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# The Alternation of Heavy and Light Crops in the Valencia Late Orange: II.

*By E. S. West, M.S.,* C. Barnard, D.Sc.,† F. E. Allan, M.A., Dip.Ed.‡*

### *Summary.*

Trials in which the fruit of the Valencia late orange was thinned and harvested at different times are described.

1. Thinning the fruit by 30 to 40 per cent. early in the season of the "on" crop year causes a slight increase in the ultimate size of the fruit left on the tree, and a considerable increase in the number of blossoms formed and fruit set during the following season.

2. Harvesting the fruit of the "on" crop early in the season (August) results in an increase in the set of fruit for the following season as compared with that of trees harvested at the normal time (November).

3. Allowing the fruit to hang on the trees until late in the season (March) does not affect the number of fruit harvested the following season, but it does affect their size.

4. A recommendation is made that an early thinning of up to one-third of the crop of the "on" year combined with early harvest should contribute to diminishing the alternate swing of biennially bearing trees.

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## 1. Introduction.

In a previous article* thinning experiments were described which showed that the removal or partial removal of the crop of the "on" or heavy year, at any time up till August, increased the subsequent blossoming and fruit finally set the following year. The earlier the thinning was carried out, the greater was the effect. As a result of these findings, it was suggested that the excessive swing of alternately heavy and light crops of Valencia oranges in the Murrumbidgee irrigation area might be reduced by a January thinning of the fruit during the "on" crop year.

During the seasons 1934, 1935, and 1936, experiments were conducted with a view to determining the effects on the subsequent season's crop of the following treatments:—

(*a*) thinning the fruit in a manner suitable for commercial practice,
(*b*) picking the fruit early,
(*c*) picking the fruit at the normal harvesting time, and
(*d*) allowing the fruit to hang late on the trees, harvesting about March.

Both very early and very late picking are practised commercially. Early harvest of portion of the crop during August is often made for export overseas, and late harvest (up till March) carries advantages in the local market. It was therefore deemed desirable to ascertain the effect of these treatments on alternate bearing, and the possibilities of their utilization in appropriate seasons in reducing the alternate cropping habit. The present article describes these experiments.

Further information has also been obtained concerning the effect of thinning the crop on the ultimate size of the fruit remaining, i.e., the effect of thinning on the current season's crop.

## 2. Effect of Thinning on the Size of Fruit of Current Season's Crop.

In the previous paper† it was pointed out that no significant differences in the size of the fruit due to thinning occurred in our experiments, although one would have expected that thinning the crop of the "on" year would have increased the size of the fruits remaining. As a result of further trials, we have come to the conclusion that thinning does slightly increase the size of the fruit left on the tree. This increase is, however very small, and is not at all comparable to that induced by thinning fruits on deciduous trees.

In Table 1 the results of trials on three different blocks of trees are set out. On Site A the experiment was conducted during the 1933 season. Approximately half of the fruit was removed during May and the thinning was done evenly over the whole tree. A certain proportion was removed from each branchlet. As this procedure has certain disadvantages‡ it was not followed in the experiment on Site B, which was carried out during 1934. In this instance, as also on Site C, the fruit was thinned to a certain density, judged by the eye, over the whole tree. Branches carrying most fruit were thinned most heavily,

* This *Journal*, 8: 93-100, 1935.
† loc cit.
‡ loc. cit., p. 98.

while little or no fruit was taken from branches bearing a light crop. The experiment on Site C was conducted during 1935. In all experiments the thinning was done during the "on" or heavy crop year of the trees used.

TABLE 1.—THE EFFECT OF THINNING ON FRUIT SIZE.

| Site. | Treatment. | Number of Trees. | Percentage Fruit Removed. | Average Number of Fruit Harvested per Tree. | Average Weight of Fruit Harvested per Tree. | Average Weight of Orange. |
|---|---|---|---|---|---|---|
| | | | | | lb. | lb. |
| A. Farm 471, Griffith | No fruit removed .. | 17 | .. | 991 | 246 | 0·25 |
| | Fruit thinned May .. | 9 | 40 | 657 | 148 | 0·23 |
| B. Farm 659, Griffith | No fruit removed .. | 4 | .. | 2,219 | 631 | 0·29 |
| | Fruit thinned March .. | 7 | 38 | 1,434 | 423 | 0·30 |
| C. | No fruit removed .. | 22 | .. | 658 | 200 | 0·30 |
| | Fruit thinned January | 22 | 37 (approx.) | 415 | 133 | 0·32 |

An analysis of variance does not reveal a significant difference in the mean weight of the fruit following thinning in any one of these trials. Nevertheless, a more detailed analysis of the 1935 experiment (Site C) shows that thinning has a definite, though slight, effect. All the fruit from each of the 44 trees was put through a size grader, and the numbers and weights of fruit in each count were recorded. The results are shown in Table 2.

It will be noted that, although the total number of fruits borne by the thinned trees was only 63 per cent. of that carried by the unthinned trees, almost as many fruits of the Count 113 occurred in the harvest of the former as that of the latter. The relative numbers of fruits in the larger size counts are greater, and in the smaller size counts are less, from the thinned than from the unthinned trees. A comparison by the $\chi^2$ test of the number of fruit falling into each grade showed the proportions in the various grades to be significantly different for the two treatments; but, as there was a big variation between the trees within each treatment, this method is not very reliable for testing treatment effects. The differences in the numbers of fruit from the thinned and unthinned trees in Counts 100, 113, and 125 are not significant when subjected to an analysis of variance, though in all other size counts the number of fruit from the unthinned trees is significantly greater than that from the thinned. This shows that the size of the fruit on the thinned trees has been increased. Finally, the effect of thinning on fruit size is shown by Fig. 1 in which the number of fruit in each count is represented as a percentage of the total number of fruits and graphs for treated and untreated trees may be compared. These detailed analyses indicate that thinning does increase the size

TABLE 2.—ANALYSIS OF FRUIT FROM THINNED AND UNTHINNED TREES—SITE C.

| Count. | | 100. | 113. | 125. | 138. | 150. | 180. | 198. | 216. | 234. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean diameter of fruit in inches | | .. | 2·76 | 2·71 | 2·67 | 2·62 | 2·50 | 2·37 | 2·27 | .. | .. |
| Number of fruit .. | Thinned | 421 | 513 | 1,181 | 1,127 | 1,565 | 1,903 | 966 | 964 | 495 | 9,135 |
| | Unthinned | 542 | 548 | 1,310 | 1,534 | 2,315 | 3,163 | 1,889 | 1,993 | 1,171 | 14,465 |
| Weight of fruit (lb.) .. .. | Thinned | 205·3 | 217·5 | 460·0 | 398·4 | 513·4 | 562·7 | 250·0 | 225·9 | 100·2 | 133 |
| | Unthinned | 263·6 | 227·2 | 479·0 | 541·8 | 754·3 | 927·8 | 489·1 | 470·1 | 236·80 | 200 |
| Mean weight per orange (lb.) .. | Thinned | ·49 | ·42 | ·39 | ·35 | ·33 | ·29 | ·26 | ·23 | ·20 | ·321 |
| | Unthinned | ·49 | ·41 | ·38 | ·35 | ·33 | ·29 | ·26 | ·24 | ·20 | ·305 |
| Ratio number of fruit—Unthinned Thinned .. | | ·78 | ·94 | ·83 | ·73 | ·68 | ·60 | ·51 | ·48 | ·42 | ·63 |

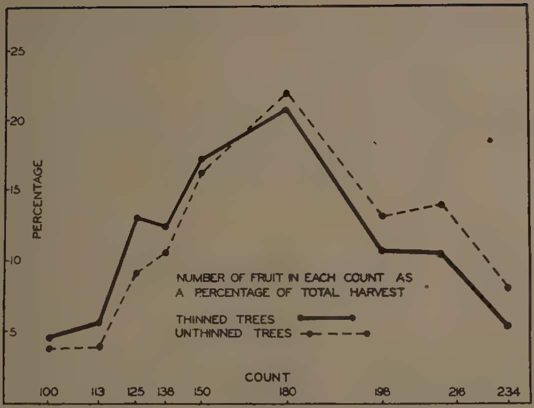


Fig. 1—Chart showing the number of fruit in each count for the harvest of thinned and control trees.

and weight* of the fruit remaining. The increase is so slight, however, that the crop is reduced by thinning nearly in proportion to the number of fruit removed. In this experiment, 37 per cent. of the number of fruits were removed in thinning and the loss of crop at harvest was 33 per cent. by weight.

### 3. The Effect of Thinning and Time of Harvest on Alternate Bearing.

During 1934, a block of 22 large, well kept, and relatively uniform trees on Farm 659 was selected. Four treatments were applied at random; these were:—

(*a*) Fruit thinned during March, 1934, as described in the preceding section for Sites B and C, 38 per cent. of the fruit removed in thinning, remainder harvested in November, eight trees.

(*b*) Fruit harvested early (August, 1934), four trees.

(*c*) Fruit harvested normal picking time (November, 1934), four trees.

(*d*) Fruit allowed to hang until March, 1935, eight trees.

Records of the yield and observations regarding the growth and appearance of the trees were made during 1935 and 1936. During these seasons the fruit from all trees was harvested in November. The results are set out in Table 3.

The effects of treatments (*a*) and (*b*) on the yield of the following season (1935) were comparable to those previously described † for similar treatments on Farm 471 during 1933-34. The yields were increased as compared with those from treatments (*c*) and (*d*). Thinning the fruit in March, 1934, increased the amount of blossom produced and fruit set for 1935. While the number of fruit was not as

* A comparison of the mean weight per orange in each count for the fruit from thinned and unthinned trees (*vide* Table 2) shows that treatment has not affected the density of the orange.

† loc. cit.

great as in the previous season (after thinning), the actual weight of fruit was greater at harvest in 1935 than in 1934. This was due to the increased size of the individual fruits of the "off" crop season. Further, though 37 per cent. of the crop was removed in 1934 from the thinned trees, the actual weight of fruit produced during the two seasons 1934 and 1935 was no less than, but as a matter of fact slightly greater than, that produced by the control trees (treatment *c*) during the two seasons. These results are in agreement with the findings of investigators in California.*

TABLE 3.—EFFECT OF THINNING AND TIME OF HARVEST ON YIELD DURING THE CURRENT AND SUBSEQUENT SEASONS.

| Treatment. | (*a*). Thinned March, 1934. | | | (*b*) Harvested August, 1934. | | | (*c*). Harvested November, 1934. | | | (*d*). Harvested March, 1935. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Harvest .. | 1934 | 1935 | 1936 | 1934 | 1935 | 1936 | 1934 | 1935 | 1936 | Mar. 1935 | Nov. 1935 | 1936 |
| Mean number of fruit .. .. | 1,434 | 1,172 | 1,581 | Not recorded. | 966 | 1,624 | 2,219 | 448 | 1,836 | 1,686 | 634 | 1,429 |
| Mean weight of fruit (lb.) .. | 423 | 496 | .. | | 409 | .. | 631 | 184 | .. | 664 | 243 | .. |
| Mean weight per fruit (lb.) .. | ·229 | ·427 | .. | | ·425 | .. | ·285 | ·449 | .. | ·382 | ·383 | .. |
| Mean weight of fruit, 1934–35 .. | 459 | | .. | .. | | .. | 407 | | .. | 453 | | |

The absence of records for treatment (*b*) in 1934 makes a complete direct analysis impossible. An analysis of variance was carried out on the number of fruit per tree for the three years and the three treatments (*a*), (*c*), and (*d*). The table of means for each treatment in each year suggests that the fluctuations were much greater in some treatments than in others, but the analysis did not establish this effect as significant. It is apparent, from the figures for the 1934 harvest, that there were considerable initial differences in the trees, and this may have caused the non-significance of the term representing the effect of the treatments on annual fluctuations, that is, the term for treatment-time interaction in the analysis of variance. It seemed desirable, therefore, to make some allowance for the yielding capacity of each tree. Accordingly, a measure of the degree of fluctuation in yield for each tree was found by dividing the difference between the numbers of fruit harvested in 1936 and in 1935 by the sum of the numbers in these two years. The values of the ratios so found were then tested for treatment differences. It was possible to include treatment (*b*) in this test. In the absence of any exact knowledge of the distributions, it was assumed legitimate to carry out an analysis of variance on these

* E. R. Parker, California Agric. Exp. Stat., Bull. 576. (1934.)

measures of fluctuation. This analysis showed that the difference between the treatments was highly significant. The following table gives the means and standard errors for the four treatments.

TABLE 4.—MEASURES OF FLUCTUATION PER TREATMENT.

| Treatment. | (a). | (b). | (c). | (d). |
|---|---|---|---|---|
| Mean .. .. .. | ·1467 | ·2502 | ·6075 | ·3559 |
| Standard Error .. .. | ± ·0658 | ± ·0880 | ± ·0880 | ± ·0711 |

Leaving the crop to hang on the trees until March allowed the fruit to grow to a larger size with a resultant increase in weight.* The late harvest did not affect the number of blossoms produced nor the fruit set for the following season, though it did have an effect in decreasing the size of the individual fruits of that season. (The differences are not quite significant.) The number of fruits harvested in November, 1936, was decreased, however, as a result of this treatment and the alternation thus damped as shown in Table 4.

The increased yields produced during 1935 in response to thinning in March and harvesting in August resulted in comparatively smaller crops during 1936 as compared with treatment (*c*). These two treatments definitely reduced the difference between the yields of the "off" and "on" crop seasons of 1935 and 1936, and diminished the extent of the alternate swing. This point is further discussed in the following section.

## 5. Discussion of Experiments on Farm 659.

The above discussion of results has been mainly confined to those which have proved significant by biometric test. Other effects of the treatments have been noted in respect to the vegetative growth of the trees and also the size of the fruit, which either could not be subjected to statistical analysis or failed to prove significant owing to the variation of the material examined. On many points, however, the authors believe that the effects noted are real. Their general conclusions regarding the performance of the trees used in these trials are therefore presented in a semi-diagrammatic and pictorial form in Fig. 2.

During March, 1934, all trees were carrying a heavy crop and were very much the same in general appearance and foliage. A little over one-third of the fruit was removed from trees in treatment (*a*) at this stage.

During August, 1934, all the fruit was picked on trees of treatment (*b*). This fruit was not fully matured. During September, though the soil was kept in a good moisture condition, the trees that were carrying the full crop showed signs of water stress when compared with those from which the fruit had been removed in August. The foliage of the latter was of a brighter green and fresher in appearance. The foliage

* The Valencia Late orange increases in size throughout the entire season. Fruit may hang for several seasons and continue to increase in size.

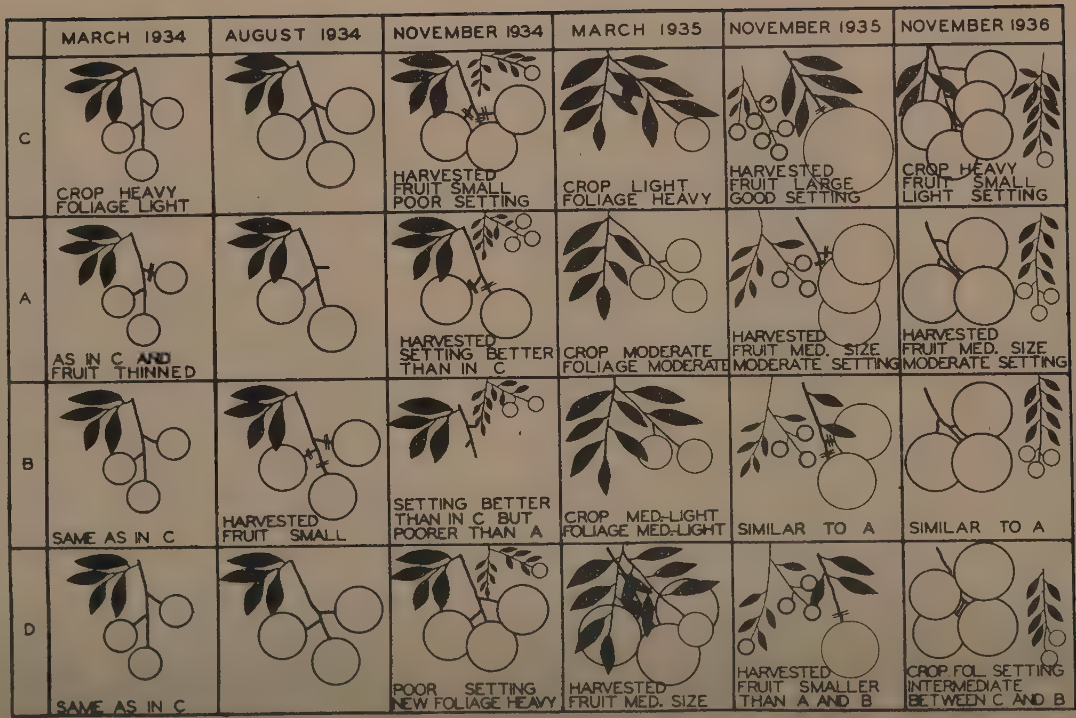


FIG. 2—Pictorial representation of fruit and leaf development in the Valencia orange during three seasons and the effect of treatments described in test.

of the trees which had been thinned in March ($a$) and were carrying a lighter crop than the trees of either ($c$) or ($d$) presented an intermediate appearance.

Blossoming occurred during October, and it was then apparent that more blossom and comparatively fewer new leaves were produced on the trees of treatments ($a$) and ($b$) than on those of ($c$) and ($d$). By November, this difference was quite marked. The crops from treatments ($a$) and ($c$) were then harvested, and the fruit from the trees which had been thinned in March ($a$) was found to be just a shade larger than that of the trees which had not been thinned ($c$). By this time the fruit for the following season had set; the greatest number were on trees of treatment ($a$), the least on trees of treatments ($c$) and ($d$), and an intermediate number on those of treatment ($b$). The amount of new season foliage was in inverse proportion to the amount of new fruit. This, as a matter of fact, must always be the case, and depends on the nature of the development of the twig.

During the first cycle of growth in spring, the twigs are limited in their extension, and for the most part growth during this phase is merely a development of parts previously formed in the bud stage.* The young shoot in the bud stage has usually about six leaves. Blossoms may be produced terminally on the shoot and in the axils of the leaves. Generally, two main types of blossom-bearing shoots are found—(1) those with only a terminal blossom, and (2) those with a terminal blossom and also axillary blossoms. In the spring of the "on" crop year, the majority of blossoming shoots are of type (2) class, while in the "off" season most of the blossom is produced on type (1) shoots. Shortly after the bud unfolds and the young shoot emerges, any leaves which subtend a blossom are abscissed. Thus the more numerous the axillary blossoms the fewer are the leaves produced. Besides the decrease in the number of leaves on the blossom shoots, there are fewer purely vegetative twigs in the season of heavy blossoming. This explains how the number of young leaves in November, 1935, were more or less in inverse proportion to the number of fruits developed.

Leaving the crop on the tree until March, treatment ($d$) allowed the fruit to grow to a larger size. Though it could not make any difference to the number of fruit set for the 1935 season, it did appreciably decrease the size of the fruit of this season as compared with the fruit of treatment ($c$). During the period November 1934—March 1935, the 1934 crop has been continuing to grow and has competed directly with the developing fruits of the 1935 season.

At the harvest in November, 1935, the same number of fruit was picked from treatments ($c$) and ($d$). While the fruit of treatment ($c$) was very large and coarse—typical off-year fruit—that from treatment ($d$) was of much the same size as in the preceding "off" year. More fruits were picked from treatments ($a$) and ($b$), the number from ($a$) approximating that harvested in 1934 but being of much larger size.

Again the amount of blossom produced varied more or less inversely with the number of fruit harvested, and the amount of spring foliage inversely with the amount of blossom.

* Loc. cit.

By comparing the harvests of November, 1935, and November, 1936, it will be seen that the alternate bearing habit is most marked in treatment (*c*). It has been very slightly reduced by treatment (*d*). Treatments (*a*) and (*b*) have tended to even up production, and in this respect treatment (*a*) has been most effective.

## 6. Recommendations.

It is suggested that a moderate thinning of fruit of the "on" crop early in the season constitutes an effective step towards reducing the swing from heavy to light crops in biennially cropping trees. The aim in thinning should be to remove fruits from the most heavily-laden branches, and thus even-up the distribution of fruit as well as lightening the crop generally. It may also be reasonably assumed that a thinning which removes up to one-third of the crop should not result in a reduction of the total yield from the trees during the season of treatment and the two subsequent seasons.

The early harvest in August of portion of the crop or of the whole crop during the "on" year should also contribute to correcting the alternate bearing habit. Again, it would be advisable to make such pickings from trees or branches bearing the most fruit. On the other hand, early picking for export during the "off" season cannot be recommended, as it would probably tend to increase the yield of the following "on" season and thus accentuate the difference between the crops of "on" and "off" years.

For harvesting fruit late in the season, the crops of trees in the "on" year should be chosen. In the first place, if fruit of the "off" year is allowed to hang late, it grows inordinately large and is thus not so desirable commercially. In the second place, the size of the fruit in the following "on" year, which in any case would tend to be on the small side, would be decreased. Thirdly, it would tend to increase the alternation in cropping. Allowing the fruit to hang late during the "on" crop season, on the other hand, not only tends to decrease the size of fruit in the following "off" year and is thus desirable, but it also tends to diminish rather than to increase the difference in "on" and "off" crop yields.

# Scientific Papers from the Division of Economic Entomology published elsewhere than in the Council's Publications.

In previous issues of this *Journal* (5:184, 1932, and 7:215, 1934), articles appeared in connexion with scientific papers for which officers of the Council's Division of Economic Entomology were responsible, but which had been published elsewhere than in the Council's publications. The article that follows brings the former lists of publications up to date.—Ed.

Evans, J. W., 1934.—A revision of the *Ipoinae* (Homoptera, Eurymelidae). *Trans. Roy. Soc. Sth. Aust.*, **58**: 149.

This group of purely Australian leaf hoppers considered up to now as a tribe of the Eurymelidae is here raised to sub-family rank and subdivided in its turn, into four tribes: Ipoini, Ampoini, Cornutopoini, and Opoini. The twenty-eight species studied, nineteen of which are new, are distributed among twelve genera, eleven of these have been erected to receive them. Figures are given for all species, especially of the male genitalia. The paper ends with the description of two new species of the Bythoscopinae.

Freney, M. R., 1934.—Studies on the merino fleece. II. A rapid method of separating cholesterol and "isocholesterol" of wool wax. *J. Soc. Chem. Ind.*, **53**: 289T–290T.

The Tswett method of chromatographic adsorption provides a rapid means of separating closely related coloured compounds. This method, using alumina as the adsorbing medium, was used to separate the laevo- and dextro-rotatory sterols of wool wax. The adsorption was carried out on the crude, non-saponifiable matter. The cholesterol was found to be adsorbed in a band near the top of the column and the "isocholestrol" formed a band at a lower level. Lanosterol and agnosterol were not separated in the experiments described.

Fuller, M. E., 1936.—Notes on the biology of *Scaptia auriflua* Don. (Diptera, Tabanidae.) *Proc. Linn. Soc. N.S.W.*, **61**: 1-9 (May, 1936).

*Scaptia auriflua* is one of the more primitive of the Australian March flies. Its habits, life history, and the morphology of the early stages, are described and compared with the American *Goniops*, the only related form of which the life history has been recorded.

Fyfe, R. V., 1935.—The lantana bug in Fiji. *Agric. J. Fiji*, **8**: (1), 35-36 (Suva, 1935).

An attempt was made to identify the factors responsible for limiting the activities of *Teleonemia lantanae* Dist. in Fiji before introducing this insect into Australia. The most important predatory insect is the Lygaeid bug, *Germalus pacificus*, which feeds on the nymphs of *T. lantanae*. Adults and 5th instar nymphs were also found to be attacked by a fungus, *Hirsutella* sp., which spreads very rapidly during the rainy season. Other natural enemies of *T. lantanae* were adults of *Coccinella repanda transversalis* F., and larvae of *Hemerobius* sp. Torrential rain often broke off lantana leaves, and the nymphs feeding on them soon died.

Fyfe, R. V., 1936.—The biological control of *Clidemia hirta* in Fiji. *J. Aust. Inst. Agric. Sci.*, **2**: (1) 8–9 (March, 1936).

The history of the biological control of *Clidemia hirta* by *Liothrips urichi* Karny, in Fiji is briefly reviewed. The thrips which was introduced into Fiji from Trinidad in 1930 so weakens the weed that rapidly-growing, vigorous plants over-run the stunted weed and kill it. Weeding costs have now been reduced by 75 per cent.

Holdaway, F. G., 1935.—Standard laboratory colonies of *Eutermes exitiosus* Hill for timber testing under controlled conditions. *J. Aust. Inst. of Agric. Sci.*, **1** (i): 34-35.

This is a preliminary note of the development of a quantitative laboratory method of measuring the resistance of materials to termite attack by means of standard laboratory colonies of a strength of 5,000 worker termites. The resistance of a material to termite attack is measured in terms of the amount of material eaten by the standard population and the percentage of the original population surviving at the end of three months or, if the colony succumbs before this time. the time in which the colony dies out.

Holdaway, F. G., and Mulhearn, C. R., 1934.—Sheep sweat a factor in blowfly attack of sheep. *Nature* **134**: 813.

This note draws attention to one of the more important conclusions of work published in greater detail in the Councils' Pamphlet 48 ("Field observations on weather stain and blowfly strike of sheep with special reference to body strike"). A high sweat or water-soluble fraction in the wool yolk of sheep predisposes them to blowfly attack.

Nicholson, A. J., 1935.—Scientific method in the study of biology. *J. Aust. Inst. Agric. Sc.*, **1**: (1), 18-21.

A brief account of scientific method as applied to biology is given, stress being placed upon the prime importance of mental discipline, upon the complementary parts played by the collection of facts and interpretation, and upon the importance of critically checking already accepted facts and theories before proceeding with an investigation.

Nicholson, A. J., and Bailey, V. A., 1935.—The balance of animal populations. Part 1. *Proc. Zool. Soc. Lond.*, 1935, pt. 3, 551-598.

This paper deals with the mathematical investigation of the problems of the balance of animal populations.

The problem of competition between animals when searching for the things they require for existence is examined. It is shown that, even when individual animals search systematically, the searching of populations is always random, and that the competition resulting from random searching can be expressed by a simple formula or curve of general application. The interaction in the steady state of specific entomophagous parasite and its specific host is examined. The steady state of interacting entomophagous parasites and hosts, having discontinuous interaction, is examined in the following situations:—Several specific parasites attack a common host; specific parasites are themselves attacked; a parasite attacks two or more specific hosts. The effects produced by the modification of the area of discovery of a parasite, by

the introduction of an additional specific parasite, and by the modification of the power of increase of a common host, are also investigated. It is shown that the steady state may exist in all the situations just mentioned, provided that the animals have properties that lie between certain limits, and that Volterra's conclusion, that only an even number of interacting species can be in a steady state, is incorrect. The problem of the interaction of entomophagous parasites and their hosts when not in the steady state is examined for certain relatively simple types of interaction. It is concluded that the interaction of animals may by itself cause the densities of the animals to oscillate about their steady values. According to the circumstances, the magnitude of the oscillations may decrease, remain constant, or increase with time. In the latter situation, the oscillation may ultimately split the species-population into numerous small groups of individuals, which fluctuate in density independently of one another. The problem involving continuous interaction between entomophagous parasites and their hosts is discussed. It is concluded that it is essential to consider the effects of age-distribution. When this is done, it is found, as in the previous problem, that the interaction of two species leads to oscillations of the animal densities about their steady values, and that the magnitude of these oscillations increases with time. The discussions by Lotka and Volterra of the problem involving continuous interaction are criticised, and are shown to lead to results inconsistent with some of the conclusions of the more rigorous theory, due to Bailey, in which the effects of age-distribution are explicitly considered. The detailed conclusions are expressed algebraically and illustrated graphically.

Tillyard, R. J., 1934.—The entomological control of noxious weeds in the Pacific Region. Proc. Vth. Pacific Science Congress, pp. 3547-3557, 1934.

This paper gives a brief account of the general principles of control of noxious weeds by the use of insects, and of the investigations in progress and the results achieved in the Pacific Region. The prospects of control of ragwort, blackberry, gorse, and piri-piri in New Zealand, and St. John's wort, noogoora burr, and ragwort in Australia by the use of various insect enemies of these weeds are discussed. The outstanding success achieved by this method is the control of prickly pear in Australia by the caterpillars of the moth—*Cactoblastis cactorum.* The lantana bug—*Teleonemia lantanae*—has done good work in controlling lantana in the drier regions of the Hawaiian Islands and Fiji. In Fiji also, another bad weed, *Clidemia hirta,* has been held in check by *Liothrips urichi.*

Tonnoir, A. L., 1935.—The Australian species of the Genus *Phlebotomus. Bull. Ent. Res.,* **26**: (2), 137-147.

Only one species of these haematophagous Diptera was so far known in Australia. In this paper, two other species and one sub-species are described and figured in detail. They were obtained in the Federal Capital Territory and its vicinity. One of them at least is capable of biting man. Taxonomic characters, especially those given by the venation and the genitalia of the group, are also discussed.

# Yellow Dwarf of Tobacco in Australia: I. Symptoms.

*By A. V. Hill, M.Agr.Sc.**

*Summary.*

Yellow dwarf is a destructive and widespread disease of tobacco in Australia. It has been observed in fields in Victoria, New South Wales, southern Queensland, and South Australia. It is most serious in Victoria, causing, in some seasons, crop reduction of 50 per cent. in certain districts and total loss in some fields.

The most obvious symptoms are dwarfing and yellowing of the plants and bending down of the margins and tips of young leaves. The disease is transmissible by grafting and budding. Observations suggest than an insect vector is responsible for its transmission in the field.

## 1. Introduction.

Dwarfing or stunting of tobacco is a disease which in some years causes heavy losses in Victoria, New South Wales, South Australia, and southern Queensland. In certain districts it is sometimes of greater economic importance than downy mildew (blue mould). Unlike the latter, which is most destructive in seedbeds, dwarfing is not a seedbed disease but usually begins to appear in the field a few weeks after transplanting. Transplants stunted by downy mildew sometimes recover and later produce a fair crop, but those dwarfed by the disease dealt with in this paper do not; experienced growers therefore eradicate plants that are attacked early. Under field conditions the most obvious symptoms are a dwarfed habit of growth and yellowing of the leaves; it is therefore proposed to designate the disease "yellow dwarf" and to recommend the name for general usage.

As far as can be ascertained from the literature, yellow dwarf has not been reported from other countries. Its occurrence (at Myrtleford, Vic.), was reported by Dickson (1) in 1929 as "dwarfing," and in each subsequent year it was noted by the writer in New South Wales and Victoria. In the latter State, McDonald (4) referred to the disease as "stunting," and reported up to 38 per cent. of stunted plants in experimental plots at Myrtleford in the 1935-36 season. At Pomonal, Vic., in the same season, yellow dwarf caused complete crop failure in several fields and a reduction of 50 per cent. of the potential yield of the district.† In 1935-36 and 1936-37, similar losses occurred in the Shepparton district, Vic., and in the northeast district, Vic., about 15-25 per cent. of the plants were dwarfed. The average reduction in yield in Victoria over the last seven years is conservatively estimated at 10 per cent.† At Tumut, N.S.W., during the 1929-30 and 1936-37 seasons, 25 per cent. of the crop was affected by yellow dwarf. In 1932, Angell‡ reported that "The disease is very serious in Tumut this season, causing crop reduction estimated at from 15 per cent. in lightly infected fields (of which there are but few), to 75 per cent. or more in the majority

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† Figures supplied by W. J. B. McDonald, Inspector of Agriculture, Department of Agriculture, Victoria.

‡ In report of Senior Pathologist, Division of Plant Industry, C.S.I.R. (unpublished).

of fields. The symptoms are the same as observed by me in the Myrtleford district of Victoria during the 1928-29 season." The proportion of diseased plants in individual fields in the Tamworth and Ashford areas, N.S.W., and the Texas district, Queensland, in the 1936-37 season varied from 3 to 17 per cent., the northern areas being least affected. During the 1936-37 season, Allan* found that in most fields in South Australia only 1 per cent. of the plants were attacked by yellow dwarf. However, 15 to 20 per cent. of the plants in a few fields were affected. In all the districts mentioned, growers stated that such plants occurred in their fields every year, and that in some seasons heavy loss resulted.

Yellow dwarf causes more loss in Victoria and southern New South Wales than in other areas. The percentage of diseased plants in a district or field varies in different years, and is reported to be influenced in part by variety (4, 5, 6). The extent of infection in different years appears to be correlated with the time of planting and weather conditions prevailing after transplanting. It is apparent from this brief review that the disease is not only widespread but is more important economically than is generally realized.

The condition of plants in the field has been commonly ascribed to downy mildew, rootrot, poor seed, poor transplants, careless transplanting, and weather conditions. Experimental evidence indicates that it is not due to fungi, bacteria, soil toxicity, or deficiency of nutrients. It is, however, transmissible by grafting and budding, and therefore appears to be due to a virus. The influence of weather conditions on its occurrence, and the distribution of affected plants in the field, lend support to the tentative view that it is transmitted by an insect. In this introduction to its study, an account is given of the more obvious symptoms, under field conditions, on varieties commonly grown in Australia for flue-curing.

## 2. Description.

Yellow dwarf usually begins to appear a few weeks after transplanting. The diseased plants, especially if affected when quite young, may be distinguished from a distance not only by their dwarfed habit, but by the yellowish colouring of the leaves. Healthy plants grow rapidly, but diseased ones develop very slowly. There is consequently a marked difference in height between them (Plate 7, Fig. 1.) In this respect the general appearance of badly affected fields appears to be somewhat similar to that of those affected by black root rot (*Thielavia basicola* Zopf. (2) or brown root rot (cause unknown) (3) in the United States.

Diseased plants usually have as many leaves as adjoining healthy ones, but the stem is often only one-third the normal length, the internodes being very short. The leaves are proportionately small, of poor quality, and generally unsuitable for commercial requirements. The flowers and capsules are few, but in other respects appear normal. Diseased plants flower at about the same time as healthy ones, but the leaves mature earlier, those on the lower third of the plant often being

* In report of Assistant Pathologist, Division of Plant Industry, C.S.I.R. (unpublished).

dead before the seed begins to ripen. The root system does not differ in general character from that of healthy plants, but it is less extensive, the roots appearing slightly brown externally and in the region of the phloem. If suckers are produced they lack vigour, the young leaves, like those at the apex of the plant, being typically rolled and bent, and sometimes thickened, rugose, and twisted. Yellow dwarf persists in diseased overwintered tobacco plants, the symptoms appearing on the new growth in the following spring.

The earliest symptom is, in most plants, a rolling under of the margins and downward bending of the tips of the young apical leaves, the distal part being often almost at right angles to the rest (Plate 7, Fig. 2). The young leaves may be darker green than normal, are closely grouped around the bud, and later have a ribbed appearance on the ventral surface. As they grow older, the dark green colour changes to yellow green, the colour change beginning in the tissues farthest from the main veins and gradually extending towards them. Rolling and bending may persist until the leaves are almost fully grown, and if this occurs, the portions of the blade on either side, and adjacent to, the lateral veins are slightly ridged, and the interveinal tissues depressed. The older leaves are rugose and thickened (Plate 8, Fig. 2) and later assume a savoy appearance. The margins and tips generally bend down (Plate 8, Fig. 1). Brown dead areas along the margins and small reddish-brown to white spots, about 2 mm. in diameter, sometimes occur on the older leaves, but it is not yet known if these symptoms are due to this or to another disease. In general, the symptoms of the disease in a mature plant appear to be very much like those typically associated with deficiency of potash under field conditions, described and illustrated by Moss and others (7).

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# A Laboratory Kiln for the Development of Kiln Drying Schedules.

*By C. Sibley Elliot, B.Sc.**

## 1. Introduction.

Small scale laboratory kilns, sometimes referred to as "pilot kilns," have had their place in the kiln schedule work of various Forest Products Laboratories of the world for a number of years, and their value has been proved beyond doubt. While the designs in use vary considerably, there is probably little if anything to choose between one design and another in so far as ultimate performance is concerned. There is, however, considerable difference from the points of view of simplicity of design, cost of construction, and ease of obtaining uniform circulation when the kilns are first put into operation.

The main object of this short article is to give details of a kiln which the Seasoning Section of the Division of Forest Products has found to give satisfactory performance and which is simpler in construction than other laboratory kilns which the Section has used or has seen in operation. It requires, moreover, no baffling whatsoever in order to obtain uniform circulation. No credit is claimed for its design, as it is simply a small scale model of a commercial design commonly known as the cross-shaft, internal-fan kiln.

## 2. General Points concerning Laboratory Kilns.

The outstanding advantage of small laboratory kilns lies in the fact that a small charge is used, thereby eliminating the risk of spoiling a valuable parcel of timber in preliminary investigations. This fact also constitutes the one limitation of such kilns, since, with a material as variable as wood, a small charge may not be truly representative of the species being investigated. Recognition of this limitation is essential, but the experience of the Division of Forest Products has been that care in obtaining samples from different trees and different localities is an adequate safeguard against this limitation. Thus, of the considerable number of species for which the Division has developed tentative schedules in these small kilns, using charges containing not more than 24 short boards, for the most part, in only one or two instances have even slight modifications of schedules been found desirable as a result of further work in commercial kilns. The one factor that cannot be studied fully with the short boards used is that of warping due to sloping grain, and even in this regard sufficient warning is obtained of possible difficulties in the drying of commercial lengths.

The schedules evolved in these small kilns can be applied directly in commercial kilns, though the drying times may be somewhat different. However, the drying times in different design of commercial kilns vary, also, and the experience of the Division has been that the drying time in an efficient commercial kiln with a stack width of approximately 5 feet is practically the same as in the small laboratory kilns.

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There are two other advantages of small laboratory kilns which of themselves have made it possible for the Division to carry out the work it has done in developing schedules. The first is that the cost of installation, apart from automatic control equipment, which is essential, is quite small. A small, low pressure steam boiler is necessary, of course, if a steam supply is not available otherwise. The second of these advantages is that the entire handling of the charges can be done by the research and technical staff without any additional labour cost.

The actual size of the kilns is a matter for decision according to local resources. The dimensions given in the accompanying plans are the least that could be used in order to obtain results of practical value, and, while it is admitted that slightly larger kilns are sometimes desirable, attention is again drawn to the proven, practical value of the results obtained by the Division over some six years' work in kilns of this capacity.

## 3. Details of Construction.

The kiln to be described is a small cross-shaft, internal-fan kiln built, so far as cross sectional dimensions are concerned, to one quarter the scale of the more or less standard size for commercial kilns in Australia. The length is just sufficient to take boards 18 inches long, these being end-coated to prevent rapid end drying. Plate 9 is a front view of the kiln with the door removed and a charge in place. Plate 10 is a view of the back and one side of the kiln, showing the arrangement of steam supply pipes, &c.; and Fig. 1 shows the details of construction.

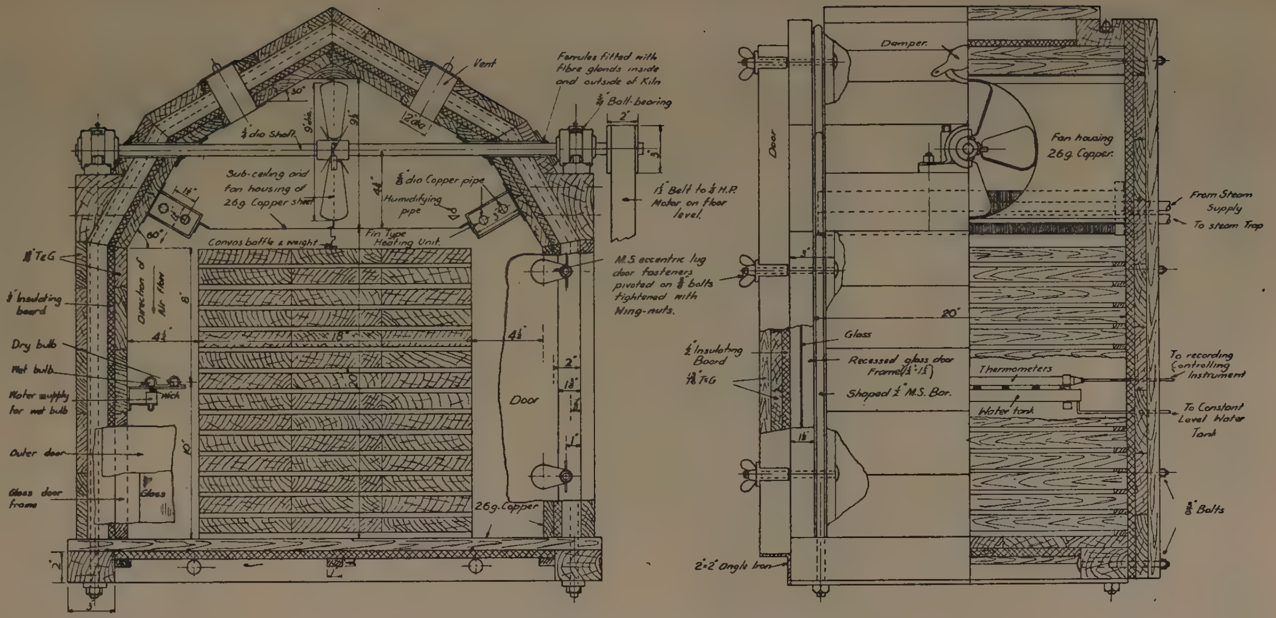
*Kiln Construction.*

The kiln is of wooden construction, lined with sheet metal (26-gauge copper or aluminium). It is built in three sections, namely, the main body, the back wall, and a door which comprises the entire front of the kiln.

The body consists of a frame built of 3-in x 2-in. wooden members, covered on both sides with tongued and grooved flooring stock. One layer of ½-in. insulating board is fastened in the spaces between the framing members and the T. & G. coverings. The sheet metal lining covers the entire inner face and extends round the edges on to the outer layer of T. & G. Towards the back and towards the front, the body is strapped by a ½-in. diameter bar, let into a groove and tightened, to give rigidity, by nuts on the threaded ends of the bar at the bottom of the kiln.

The back wall and the door are built of two layers of T. & G. flooring, the lengths of the boards being vertical in the outer layer and horizontal in the inner layer. To the inner layer is fastened a layer of ½-in. insulating board, and the whole is lined with sheet metal, as in the body of the kiln.

The kiln is assembled by fastening the back to bolts set in the framework of the body, the inner face of the back being drawn tightly against ⅛-in. rubber insertion jointing. A convenient method of fastening the door is indicated in Fig. 1. Inside the door opening is a recessed glass door through which observations can be made while the kiln is in operation.




SMALL SCALE LABORATORY KILN

CROSS SHAFT TYPE

Fig. 1.

*Circulation.*

Circulation is provided by a 9-in. diameter, four-bladed, propeller fan set in a circular opening in a simple longitudinal partition and mounted on $\frac{3}{4}$-in. diameter shafting carried in ball bearings placed externally as shown in Plate 10. The fan is driven by a belt at one side, running from a $\frac{1}{4}$-h.p. motor mounted at floor level. The fan speed is 1,450 r.p.m.

*Heating and Humidifying.*

Heat is supplied through two finned tube heating units as shown in Pl. 9, and Fig. 1. Each of these units consists of two $\frac{5}{8}$-in. tinned copper pipes, arranged in a simple return bend system and passing through 3-in. x $1\frac{1}{2}$-in. tinned copper fins spaced at twelve to the inch. With a steam pressure of 10 lb. per square inch, it is seldom found necessary to use more than one of these units. Condensate from the heating units is trapped at the back of the kiln, and is used for supplying water for the wet bulb.

Humidity is controlled partly by pivoted dampers over vents in the roof and partly by a perforated steam spray pipe which can be seen in Plate 9. The spray pipe is 18 inches long and $\frac{3}{8}$ inch in diameter, and has three equally-spaced holes 1-16 inch diameter. There is a trough beneath this spray, to collect condensate.

Referring to Plate 10, steam is supplied through the pipe, L, and reaches the heating units through the automatically controlled motor valve, G, which is operated by the recorder-controller, A. Either of the heating units can be cut off by closing one of the valves, C. The condensate from the heating units is trapped in the steam trap, J, and passed to a reservoir, F, where such of it as is required passes to a trough inside the kiln, supplying water to the wet bulb wick. The balance of the condensate overflows to a drain. Should the steam trap fail to function, the condensate can be by-passed through the valve K.

Steam reaches the humidifying spray through the automatically-controlled motor valve, D.

The supply of steam to the motor valves, G and D, can be throttled by the wheel valves, H and E, respectively. If the control instrument is out of action, the motor valves can be cut out by closing valves, H and E, and the steam by-passed direct to the heating units by the hand-controlled valve I, and to the humidifying pipe by the hand-controlled valve, B. Hand control of such small kilns is not satisfactory except as a temporary expedient, however.

*The Charge.*

It is important that the charge should not be less than $4\frac{1}{2}$ inches from the wall of the kiln on the entering air side. The distance from the wall on the leaving air side does not matter, provided sufficient space is left for the air to pass up to the fan, and so the stack width can be varied, from 6 inches to 18 inches as required. Provision must be made to prevent short circuiting of the air above the stack, and this can be done simply by building up the stack to full height with dummy boards, if necessary.

It has been found essential, with a kiln of the above size and design, to use spacing strips $\frac{1}{4}$ inch thick between the boards in the charge. With thicker spacing strips, there is insufficient resistance to the air, and the circulation becomes faulty.

# The Determination of the Moisture Content of Timber by Electrical Capacity Effects: A New Meter and its Application.

*By A. J. Thomas, Dip. For., I.F.A.,* and W. L. Greenhill, M.E.†*

*Summary.*

Following a careful consideration of the possibilities of using the effect of moisture content on the dielectric constant of timber to indicate the moisture content of that timber, a new instrument has been developed to a stage suitable for commercial use. The instrument is inexpensive, small, and light, and is operated solely from alternating current power mains. It is designed to give a direct reading of moisture content, with a reasonable degree of accuracy for any species for which it is calibrated, over a range of values from zero to over 20 per cent., and it can be used with timber of any thickness up to at least two inches.

An unusual feature of the instrument is the way in which it is used to indicate timber higher in moisture content than any pre-selected value. A piece of timber at a higher moisture content than that for which the instrument is set will cause a bell to ring or give some other easily-recognized signal. Use has been made of this arrangement to check the moisture content of timber passing through a planing machine. The timber simply moves between two metal plates, and any piece higher than the previously-decided maximum permissible value is suitably signalled. It would be quite possible to extend this idea so that a trip or other device actually segregated the wetter timber.

## 1. Introduction.

During the last ten years, much attention has been devoted to developing a rapid means for determining the moisture content of timber electrically, and a number of successful instruments have been developed for this purpose. One instrument, the "blinker" moisture meter, has become widely known in Australia. This instrument was developed by Suits and Dunlap (1) at the Forest Products Laboratory, Madison, U.S.A., about 1929, and was introduced into Australia in 1931. Since then, instruments of this type have been manufactured commercially in Melbourne. The "blinker" and a number of other but less well known instruments measure indirectly the electrical resistance which increases with decrease in moisture content of timber. The instruments are generally calibrated to read the moisture content of Douglas fir directly, and, when testing other timber, correction figures have to be applied. Correction figures for about 120 Australian species have been published recently (2).

With the "blinker" type of instrument, moisture content determinations can be made rapidly, but not by any means instantaneously. The operator is required to drive the blade electrodes into each piece of timber separately and, furthermore, the range of the instrument is limited to moisture contents between about 8 per cent. and 24 per cent.

The ideal meter sought is one in which the electrodes do not have to penetrate the timber, and one which will function with moving

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timber without the constant aid of an operator, so that it can be used not only to indicate, but to signal, timber of a moisture content higher than a certain chosen value, as the timber passes on some form of chain or from some machine. The ideal meter would be capable of accurately determining the moisture content of any species over a complete range, and it would give an average figure for timber of any reasonable thickness. Other features sought are cheapness and adaptability to use on alternating current power mains instead of batteries.

An instrument involving the use of the timber to be tested as the dielectric of a condenser appeared the most promising line of investigation in the attempt to design an instrument approaching as nearly as possible to this ideal. It was kept in mind that, while considerable accuracy is desirable, possible errors up to 1 or 2 per cent. moisture content might be tolerated in commercial instruments, if the majority of the other desirable attributes were attained.

The dielectric constant of timber increases logarithmically with increasing moisture content, the dielectric constant of water being approximately 81 and that of dry wood only about 2. The moisture content of a piece of timber can, therefore, be determined by using it as the dielectric of a condenser and measuring the capacity. In such circumstances, actual contact with the timber is unnecessary. This principle has been used for determining the moisture content of wood in the Tuttle moisture meter, developed at Madison about 1926 and described by Tiemann (3), in an almost exactly similar instrument investigated by Rankine (4), in the Heilan apparatus described by Morath (5), and in the "moisture register," a recent instrument placed on the market by a Seattle firm. References are also made in a recent article by Strachan (6) to the use of dielectric variation with moisture content in paper to control the drying of the paper in high-speed machines.

The dielectric constant of timber at any one percentage moisture content varies with density, as it is the actual quantity of water present, and not the percentage, which affects the capacity. Consequently, different instrument calibrations must be used for timbers of various densities, and, when working with any one calibration, some errors will be unavoidable owing to density variations within a species. Fortunately, these variations are not nearly so great in the majority of Australian hardwoods as are those commonly encountered in timbers such as Douglas fir.

When using the meter to signal boards of too high a moisture content, the meter should be calibrated for timber from the higher end of the density range. In this case, timber of lower density would appear from the meter to be drier than it really is. From the practical point of view, an error of 1 or 2 per cent. here would be immaterial, because normally, in any kiln charge or consignment of timber, all the lower density pieces are satisfactorily dry if most of the denser pieces are, so that the main function of the instrument is to determine the moisture content of any denser boards which may be too wet.

Not one of the "capacity" instruments mentioned above is designed for use on moving timber or for indicating wet timber by a signal. The present investigations, while aiming to develop an instrument as versatile as possible, have been directed largely to the incorporating of such a feature.

## 2. Developmental.

The meter to be described was not the outcome of a single idea; it was evolved through a series of experiments which briefly were as follows. The first set-up investigated employed a U227 valve in a regenerative circuit tuning from 500 K.C. to 1,500 K.C. This was brought into oscillation and heterodyned against the wave of a suitable transmitter. Metal plates were connected to the ends of the grid coil, and the two plates used as a condenser of which a timber sample formed the dielectric. The pitch of the heterodyne whistle varied considerably with small changes in moisture content, and such an arrangement was shown to have definite possibilities as a moisture indicator. The use of higher frequencies was also investigated. These had certain advantages, and with various modifications could possibly have been employed satisfactorily.

At this stage, it appeared that a simpler instrument might be developed by the use of a resonant circuit and measuring the changes in grid or plate current brought about by changes in the capacity of a condenser introduced into the circuit and so arranged that the sample of wood to be tested formed the dielectric. A low power triode valve was first investigated, but the current changes were only small, and the question of current amplification had to be considered if a suitable relay were to be operated. Instead of doing this, however, use was made of a power valve, and most promising results were obtained by measuring the increase in plate current of a valve brought into oscillation by an increase in capacity of the "test" condenser. Smooth control of reaction was essential, and this problem, together with the most suitable placing of the "test" condenser, called for investigation. A series of experiments was carried out to test the suitability of various circuits. The advantage from a practical stand-point of having one plate of the test condenser earthed was realized and this objective attained. It was also found desirable to introduce a resistance bridge so as to measure the change in plate current rather than the actual plate current itself. The design of the relay for operating the signal presented some difficulties, as it had to have a very constant operating current.

The circuit finally developed and used is described subsequently. It is not claimed that this circuit does not permit of improvement, and certain modifications such as the use of metal valves and more efficient coils would also certainly be advantageous. As it stands, however, very satisfactory results are being obtained, and any such minor modifications can with safety be left to prospective manufacturers.*

## 3. Description of Instrument.

*General.*

The present instrument is housed in a wooden box 11 inches x 10 inches x 8 inches and weighs 14 lb. The general arrangement may be seen from Pl. 5, Figs. 1 and 2, and Pl. 6.

On the panel are two knobs, a two-way switch, and a milliameter. The meter serves to indicate the moisture content, different scales for various species being engraved on celluloid and inserted into the bezel.

* Any one requiring further particulars should apply to the Chief, Division of Forest Products, 69-77 Yarra Bank-road, South Melbourne.

It is proposed that different scales be used for different density ranges and marked with the species for which each scale is applicable.

According to the position of the switch, the instrument can be used either as a meter or as a signalling device for indicating timber of too high a moisture content. The meter cannot be placed in series with the relay because this is so designed as to break its own circuit as it closes. Consequently, in such a position, the meter would not show a current greater than that required to operate the relay. The top right-hand knob on the instrument panel serves to operate a variable resistance in series with the relay and so control the moisture content at which the relay operates. The resistance is calibrated in milliamps corresponding to the meter, so that the relay just does not close when the control is set on the same figure as the meter reading.

The lower knob is included as a zero correction for the meter in case such an adjustment is required.

On the right end of the instrument is a socket to take two wires from an external electric bell or other device. On the left-hand end is a socket to take a plug and leads from the A.C. power supply. On the same end is provision for the leads to the electrodes. One of these goes to the lower electrode, for example, the framework or bed of a planing machine, and so is earthed. The other goes to the upper electrode. When the instrument is used in a permanent position, this lead should be shielded by running it through a non-capacitative conduit; for example, it may be stretched tightly in the middle of a wooden box housing.

The instrument is used by connecting it up, turning on the power, inserting the appropriate scale on the meter face, and adjusting the zero reading if this is necessary. The timber is then placed between the electrodes. With the switch "down" the meter will indicate the moisture content. To use as a device for signalling when the timber is wetter than a certain moisture content, say 15 per cent., the switch is turned "up." The milliamps figure corresponding to 15 per cent. moisture content is noted and the top knob turned to this figure. Without further attention, any piece of timber wetter than 15 per cent. passing through the electrodes will cause the external bell to ring. If a signalling instrument only is required, the switch, milliammeter, and zero correction variable resistance may be omitted. Such an instrument could be calibrated with actual timber samples.

*List of Components.*

These numbers correspond to those shown on the circuit diagram, Fig. 1:—

1. Test electrodes.
2. Small trimming condenser built in.
3. Grid coil.
4. Plate coil coupled to grid coil.
5. .00025 Mfd. mica condenser.
6. 2-megohm grid leak.
7. 45 National Union valve, and 4-pin wafer socket.
8. 1500 ohm resistance.
9. .5 Mfd. tubular condenser.

10. Power transformer—
    Primary—tapped for 220, 240, 260 volts.
    Secondaries—(*a*) 385 volt, 60 m.a. centre tapped.
    (*b*) 5 volt.
    (*c*) 2.5 volt or other voltage to suit bell.
    (*d*) 2.5 volt, centre tapped.
    Core earthed.
11. 80 Mullard full wave rectifying valve, and 4-pin wafer socket.
12. .002 Mfd. mica fixed condenser.
13. 10 megacycle choke, multicoil type, with small coil end connected to plate coil.
14. .5 Mfd. tubular fixed condenser.
15. 1,800 ohm, 5 watt, fixed resistance.
16. 500 ohm, 5 watt, fixed resistance.
17. Three 60,000 ohm, 2 watt, fixed resistances in parallel.
18. 0–10,000 ohm, 20 mil., wire-wound variable resistance used for zero correction.
19. 0–25 milliammeter.
20. Single-pole double-throw switch.
21. 0–2,500 ohm, 30 mil., wire-wound variable resistance used to control ringing of bell.
22. Special relay (alternatively, Thyratron valves may be used).
23. 2 Mfd. condenser.
24. 100 ohm fixed resistance.
25. 2.5 volt A.C. bell (subsequently replaced by double-gong bell operating on 100 volts A.C. with current consumption of 15 mils.).

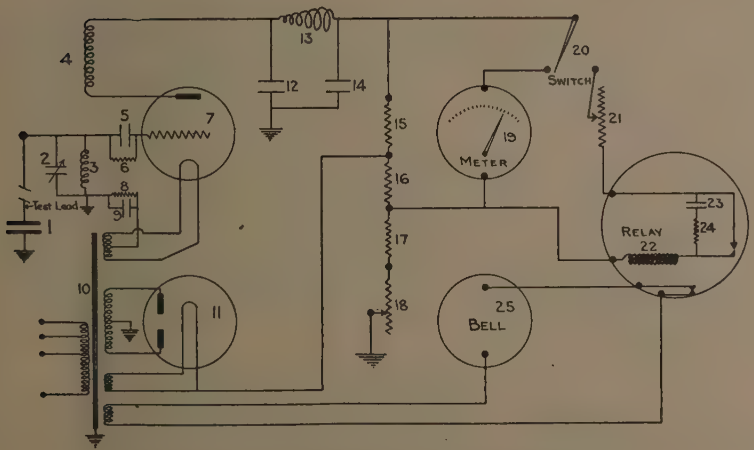


**Fig. 1.—Electrical moisture meter circuit diagram.**

*Circuit.*

The circuit used is shown in the accompanying diagram (Fig. 1), and the arrangement of the components may be seen in the illustration (Plate 6). It will be noted that use is made of a regenerative detector circuit operating on a wave length of about 30 meters (10,000 kilocycles). Increasing the capacity of the external condenser serves to bring the valve gradually into oscillation.

All leads carrying high frequency currents must be as short as possible, and, to minimize body capacity effects, shielding is necessary. To make this as effective as possible, all components have been mounted beneath an aluminium chassis, and the spindles of the variable resistances extended. The only wires above the chassis are those to the switch and meter, which are almost free from high frequency currents; consequently, the controls may be manipulated without the hand appreciably affecting the instrument.

*Coil System.*

Both coils are wound with 26-gauge D.C.C. wire on a 1¼-in. diameter ribbed composition former, housed in a 2½-in. diameter 18-gauge aluminium cylinder. The grid coil consists of fifteen turns and the plate coil six turns. The coils are spaced about ½ inch apart. The relative sizes of the coils and their spacing are very critical. Before commercial manufacture of the instrument can be commenced, this coil system will have to be standardized. At the same time, recent developments in coil construction may be incorporated.

*Relay.*

The relay in use is an electromagnetic type which is closed by a current of approximately 6 milliamps. The movement of the arm closes the bell circuit and at the same time opens the relay coil circuit. The relay circuit makes and breaks so long as the current is great enough, but, as soon as it falls below the minimum, fails to make again. This overcomes the difficulty that with a simple relay a certain current is required to close it, but a smaller current will hold it closed.

*Test Condenser.*

With this meter, the area of one plate must be adjusted according to the thickness of the timber. At present, the laboratory equipment in use consists of a copper base plate representing earth and one of a series of interchangeable brass plates of varying area fixed above it. In the planing mill, the framework of the machine is being used as the lower plate.

The top plate can be changed, raised up and down, and moved sideways to centre it over the timber, one edge of which runs against a guiding fence. The actual areas required for various thicknesses have not yet been determined, but they are approximately proportional to the thickness; for example, 14 square inches is used for 1-in. timber and approximately 7 square inches for ½-in. timber. Various thicknesses of timber may be allowed for automatically by having the top plate so arranged that the effective area is changed as the plate moves up and down.

## 4. Acknowledgments.

The authors wish to acknowledge thankfully the helpful advice given by Messrs. G. H. Witt, G. N. Smith, and B. MacDonald, of the Research Branch of the Postmaster-General's Department, especially

with regard to the choice of valve and type of relay used. They also wish to record their thanks to Mr. F. G. Nicholls, of the Radio Research Board, for many helpful suggestions and a practical demonstration of an ingenious method of current amplification.

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# The Density of Australian Timbers—Air-Dry and Green Densities for a Number of Species.

*By W. L. Greenhill, M.E.**

## 1. Introduction.

The evaluation of true density figures for wood presents difficulties on account of the varying amounts of moisture with which it is associated at various times, and because of the fact that the shrinkage which occurs during drying is influenced by the method of drying employed. To overcome these difficulties, a method has been developed in which the density of the sample is determined from its oven-dry weight and its soaked volume (1). Results so obtained are called "basic" densities, and, although they are not true densities, they serve a very useful purpose in that, being generally comparable, they may be used as a basis for identification and other such purposes. On the other hand, such figures offer little help to any one interested in the actual weight of the timber, for determining which, the weight per unit volume of the timber at the same condition is required.

With the exception of timbers which collapse severely, the variation in shrinkage due to different methods of drying is not usually sufficiently great to affect the practical value of the density figures for timber at, say, 12 per cent. moisture content. This moisture content represents approximately the average condition at which timber is used, and the true density of timber at this moisture content is the value most used in practice. The other value generally considered is the true density of the green material, that is, before drying commences.

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In the tables given in this article, true density figures, expressed in lb. per cubic foot, are given for air-dry (12 per cent. moisture content) and for green material. To eliminate to some extent inaccuracies which are apt to occur in density figures for air-dry material of timbers which collapse, results are included for material before and after reconditioning, that is, with a normal amount of collapse present and with this removed.

## 2. Details of Tests.

*Material Used.*—The same specimens were used for these density tests as for the standard tangential and radial shrinkage tests, a large number of which have been carried out by the Division of Forest Products during the last few years (2). The specimens were 1-in. x 4-in. x 1-in., and shrinkages were taken in the 4-in. direction. By weighing each specimen and determining its volume while green, it was possible to use it for a density determination without interfering with the shrinkage test.

The material from which the 1-in. x 4-in. x 1-in. specimens were cut was forwarded to the laboratory in the form of 5-in. square billets. For the most part, three billets were taken from one tree—one from the sapwoood, and one from the truewood of a butt log, and one from a top log. One tangential and one radial 1-in. x 4-in. x 1-in. specimen were cut from each billet, the method of cutting being described and illustrated elsewhere (2).

*Procedure.*—The 1-in. x 4-in. x 1-in. specimens were weighed, and their volumes determined while they were still green. In this condition the specimens were sufficiently smooth and regular to enable volumes to be determined, from linear measurements, with considerable accuracy. The dimension in the 4-in. direction was determined for shrinkage purposes, and for each of the other two dimensions the average was taken of three micrometer measurements at different positions.

Green density figures were calculated directly from the green weight and volume of both the tangential and radial specimens, and the average of the two results taken as the green density of the sample.

No other measurements were made on the specimens apart from those taken for shrinkage determinations which consisted of weekly observations during air-drying to equilibrium, and after oven-drying. The specimens were reconditioned at 12 per cent. moisture content, but no direct volume measurements were made at this moisture content, either before or after this treatment. The volumes before and after reconditioning were calculated from the green volume and the corresponding percentage volumetric shrinkage. The volumetric shrinkage for the sample was calculated from the shrinkages of the tangential and radial specimens*, and the figure so obtained applied to both these specimens. As for the green density, the averages of the results obtained with the two 1-in. x 4-in. x 1-in. specimens before and

* If $V$ = volumetric shrinkage percentage, $T$ = tangential shrinkage percentage, and $R$ = radial shrinkage percentage, then neglecting the longitudinal shrinkage, which is very small, $V = T + R - \frac{RT}{100}$

after reconditioning were taken as the respective air-dry densities for the sample. Basic densities were calculated from the green volume (which was the same as the soaked volume for all practical purposes), and the oven-dry weight of each specimen, and averaged for the sample.

## 3. Results.

In Tables 1 and 2, green and air-dry densities are given for a number of different species, the air-dry figures for both reconditioned and non-reconditioned material being included. In addition to these true densities, basic densities and green moisture contents are listed. The number of different trees and the total number of samples tested are recorded in order to indicate the range of material. The results given in Table 1 are for species of which at least eight samples have been tested, and the range within which 95 per cent. of the material will fall has been estimated from standard deviations. The results given in Table 2 are based on a smaller range of material, and no attempt has been made, with such a limited number of samples, to estimate the range of values likely to be met in these species.

The green density and green moisture content figures may be somewhat on the low side, particularly for some of the quick drying species such as *Pinus radiata*. However, for the most part, the figures are thought to be fairly accurate as, although a period of weeks sometimes elapsed between the cutting of the sample billets and the time they are delivered to the laboratory for testing, the billets were protected from drying to some extent by hessian covering. Furthermore, the small 1-in. x 4-in. x 1-in. specimens were cut well away from the ends of the billet, and as far as possible from the surface, so that they were unlikely to be very much affected by drying.

The difference between the densities of reconditioned and non-reconditioned material at 12 per cent. moisture content gives an indication of the extent to which collapse occurs in the several species.

## 4. Acknowledgment.

The author wishes to thank Dr. M. Barnard, of the biometrical staff of the Council, for the assistance given in preparing and tabulating the results.

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TABLE I.—DENSITY FIGURES FOR 85 AUSTRALIAN TIMBERS (8 OR MORE SAMPLES).



| Species. | | Range of Material. | | Basic Density lb. cu. ft. | | Green Moisture Content %. | | Green Density lb./cu. ft. | | Air Dry Density (lb./cu ft.) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Before Reconditioning. | | After Reconditioning. | |
| Botanical Name. | Common Name. | No. of Trees. | Total No. of Samples. | Mean. | Range.* | Mean. | Range.* | Mean. | Range.* | Mean. | Range.* | Mean | Range.* |
| *Acacia implexa* .. | Hickory .. .. | 4 | 12 | 36 | 24–48 | 93 | 59–126 | 69 | 54–85 | 43 | 29–57 | 43 | 29–57 |
| ,, *melanoxylon* | Blackwood .. .. | .. | 24 | 34 | 25–43 | 117 | 66–167 | 74 | 59–86 | 40 | 29–51 | 39 | 29–50 |
| ,, *penninervis* .. | Mountain hickory .. | 6 | 9 | 40 | 34–46 | 74 | .. | 70 | .. | 48 | 41–55 | 47 | 40–54 |
| *Ackama muelleri* .. | Brown alder .. | 5 | 15 | 32 | 25–39 | 112 | 76–148 | 68 | 55–80 | 43 | 34–52 | 40 | 31–49 |
| *Agathis palmerstoni* .. | North Queensland kauri | .. | 8 | 25 | 24–26 | 84 | .. | 45 | .. | 29 | 25–33 | 29 | 25–33 |
| *Ailanthus imberbiflora* .. | White sirus .. .. | 3 | 9 | 22 | 18–26 | 108 | 105–110 | 46 | 39–51 | 27 | 22–32 | 27 | 22–31 |
| *Alphitonia excelsa* .. | Red ash .. .. | 7 | 21 | 34 | 25–43 | 75 | 56–95 | 60 | 45–74 | 42 | 33–51 | 41 | 31–50 |
| *Aphnanthe philippinensis* | Grey handlewood .. | 6 | 18 | 37 | 33–41 | 71 | 60–83 | 63 | 58–70 | 45 | 36–54 | 44 | 39–49 |
| *Araucaria cunninghamii* | Hoop pine .. .. | .. | 10 | 29 | 26–31 | 50 | .. | 43 | .. | 34 | 31–38 | 34 | 31–38 |
| *Arytera lautereriana* .. | Blush tamarind .. | 5 | 15 | 35 | 30–41 | 50 | .. | 53 | .. | 45 | 30–61 | 42 | 36–49 |
| *Athrotaxis selaginoides* .. | King William pine .. | .. | 12 | 21 | 18–23 | 84 | 59–108 | 39 | 32–44 | 25 | 21–28 | 24 | 21–28 |
| *Backhousia myrtifolia* .. | Ironwood .. .. | 5 | 15 | 50 | 46–55 | 44 | 30–57 | 72 | 65–79 | 65 | 59–72 | 64 | 56–72 |
| *Balogia lucida* .. | Ivory birch .. .. | 3 | 9 | 38 | 32–45 | 64 | 42–85 | 62 | 56–68 | 47 | 40–54 | 46 | 38–54 |
| *Beilschmiedia obtusifolia* | Blush walnut .. | 3 | 9 | 39 | 34–45 | 61 | 47–75 | 63 | 59–68 | 48 | 41–54 | 47 | 40–54 |
| *Brachychiton acerifolius* | Flame kurrajong .. | 8 | 24 | 20 | 9–32 | 135 | 71–200 | 47 | 24–69 | 26 | 10–41 | 25 | 11–39 |
| ,, *discolor* | White kurrajong .. | 3 | 9 | 12 | 7–18 | 225 | 59–392 | 40 | 25–57 | 14 | 8–21 | 14 | 8–21 |
| *Callitris glauca* .. | Cypress pine .. | .. | 10 | 36 | 30–42 | 64 | .. | 59 | .. | 42 | 35–49 | 42 | 35–49 |
| *Casuarina cunninghamiana* | River sheoak .. | 6 | 17 | 36 | 30–43 | 84 | 81–87 | 66 | 60–73 | 47 | 41–53 | 44 | 36–51 |
| ,, *fraserana* .. | Sheoak .. .. | .. | 18 | 39 | 33–45 | 79 | 59–99 | 70 | 62–77 | 46 | 39–53 | 45 | 38–52 |
| ,, *suberosa* .. | Black sheoak .. | 5 | 14 | 38 | 36–40 | 79 | 60–98 | 68 | 63–73 | .. | .. | 47 | 44–50 |
| ,, *torulosa* .. | Forest sheoak .. | 3 | 9 | 52 | 47–57 | 45 | 42–48 | 75 | 68–82 | 62 | 57–67 | 60 | 55–66 |
| *Cedrela toona* var. *australis* | Red cedar .. .. | 3 | 9 | 25 | 19–31 | 98 | 84–114 | 51 | 35–72 | 31 | 21–41 | 31 | 21–40 |
| *Ceratopetalum apetalum* | Scented satinwood .. | 15 | 24 | 31 | 23–39 | 85 | 48–122 | 58 | 53–71 | 41 | 31–51 | 39 | 29–50 |
| *Chariessa moorei* .. | Silky beech .. .. | 8 | 24 | 35 | 31–38 | 90 | 68–113 | 67 | 61–71 | 45 | 40–50 | 42 | 37–46 |
| *Cinnamomum oliveri* .. | Camphorwood .. | 3 | 9 | 30 | 25–34 | 70 | 58–82 | 51 | 43–58 | 36 | 30–41 | 35 | 30–41 |
| *Cryptocarya erythroxylon* | Rose maple .. .. | 5 | 16 | 35 | 30–40 | 74 | 46–103 | 61 | 55–67 | 43 | 37–50 | 43 | 36–50 |
| ,, *glaucescens* | Silver sycamore .. | 5 | 15 | 31 | 25–36 | 85 | 61–109 | 57 | 49–64 | 38 | 31–46 | 37 | 26–49 |
| ,, *obovata* .. | Laurel silkwood .. | 4 | 12 | 32 | 26–39 | 86 | 52–120 | 60 | 48–73 | 40 | 30–49 | 40 | 30–49 |
| *Dacrydium franklini* .. | Huon pine .. .. | .. | 8 | 26 | 24–29 | .. | .. | .. | .. | .. | .. | 31 | 18–44 |

| Species. | | Range of Material. | | Basic Density lb./cu. ft. | | Green Moisture Content %. | | Green Density lb./cu. ft. | | Air-Dry Density (lb./cu ft.) Before Reconditioning. | | Air-Dry Density (lb./cu ft.) After Reconditioning. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Botanical Name. | Common Name. | No. of Trees. | Total No. of Samples. | Mean. | Range.* | Mean. | Range.* | Mean. | Range.* | Mean. | Range.* | Mean. | Range.* |
| *Daphnandra micrantha* .. | Sassafras .. .. | 4 | 11 | 33 | 29–38 | 104 | 57–150 | 67 | 58–77 | 41 | 35–47 | 40 | 34–46 |
| *Diosporous pentamera* .. | Grey persimmon .. | 7 | 21 | 36 | 31–42 | 73 | 63–83 | 62 | 58–68 | 46 | 42–50 | 45 | 35–55 |
| *Diploglottis cunninghamii* | Tamarind .. .. | 7 | 20 | 35 | 27–44 | 62 | 44–80 | 57 | 41–71 | 42 | 29–54 | 42 | 29–54 |
| *Doryphora sassafras* .. | N.S.W. sassafras .. | 12 | 21 | 30 | 13–48 | 89 | 39–139 | 57 | 46–68 | 37 | 30–44 | 36 | 29–43 |
| *Duboisia myoporoides* .. | Yellow basswood .. | 3 | 9 | 23 | 17–30 | 141 | 41–250 | 56 | 45–66 | 29 | 22–35 | 28 | 22–35 |
| *Dysoxylum fraseranum* .. | Rose mahogany .. | 8 | 16 | 38 | 33–42 | 87 | 66–108 | 71 | 62–79 | 45 | 39–52 | 45 | 39–51 |
| „ *muelleri* .. | Miva mahogany .. | 4 | 12 | 33 | 26–41 | 96 | 52–140 | 65 | 55–76 | 40 | 31–49 | 40 | 31–49 |
| *Ehretia acuminata* .. | Silky ash .. .. | 5 | 14 | 31 | 26–35 | 78 | 56–100 | 55 | 50–59 | 38 | 33–44 | 36 | 31–42 |
| *Elaeocarpus grandis* .. | Silver quandong .. | 7 | 21 | 24 | 20–29 | 88 | 66–109 | 45 | 36–56 | 29 | 24–34 | 29 | 24–33 |
| *Endiandra palmerstoni* .. | Queensland walnut .. | .. | 8 | 36 | 30–42 | 62 | .. | 58 | .. | 44 | 37–51 | 43 | 36–50 |
| *Eucalyptus astringens* .. | Brown mallet .. | .. | 14 | 48 | 44–52 | 43 | 30–57 | 69 | 66–72 | 61 | 56–66 | 59 | 55–64 |
| „ *gigantea* .. | Alpine ash .. .. | .. | 19 | 33 | 27–40 | 101 | 69–133 | 66 | 60–72 | 42 | 33–51 | 41 | 32–50 |
| „ *globulus* .. | Southern blue gum .. | 10 | 12 | 41 | 35–48 | 73 | 47–100 | 71 | 63–80 | 56 | 47–66 | 51 | 44–58 |
| „ *grandis* .. | Rose gum .. .. | .. | 18 | 39 | 29–49 | 69 | 41–97 | 66 | 54–77 | 50 | 38–62 | 48 | 35–61 |
| „ *leucoxylon* .. | Yellow gum .. | 6 | 8 | 50 | 42–58 | 50 | 32–68 | 75 | 69–80 | 62 | 52–72 | 60 | 50–70 |
| „ *maculata* .. | Spotted gum .. | .. | 39 | 51 | 44–57 | 45 | 29–61 | 74 | 68–79 | 63 | 56–71 | 61 | 54–69 |
| „ *obliqua* .. | Obliqua .. .. | .. | 28 | 35 | 29–41 | 96 | 52–141 | 68 | 56–80 | 47 | 39–55 | 43 | 34–52 |
| „ *paniculata* .. | Grey ironbark .. | 3 | 10 | 53 | 49–57 | 38 | 26–50 | 73 | 67–79 | 65 | 63–68 | 65 | 62–67 |
| „ *pilularis* .. | Blackbutt .. .. | .. | 40 | 43 | 36–50 | 63 | 29–96 | 70 | 58–81 | 54 | 44–65 | 53 | 44–62 |
| „ *regnans* .. | Mountain ash .. | .. | 130 | 32 | 26–37 | 101 | 67–136 | 63 | 56–70 | 44 | 36–53 | 39 | 32–47 |
| „ *redunca* .. | Wandoo .. .. | 5 | 20 | 58 | 56–59 | 37 | 32–42 | 80 | 75–83 | 70 | 68–72 | 69 | 67–70 |
| „ *rostrata* .. | Red gum .. .. | .. | 34 | 43 | 35–51 | 65 | 34–96 | 71 | 64–77 | 56 | 49–62 | 52 | 43–61 |
| „ *saligna* .. | Sydney blue gum .. | .. | 18 | 40 | 31–50 | 73 | 39–107 | 69 | 60–78 | 52 | 38–65 | 49 | 36–62 |
| „ *tereticornis* .. | Forest red gum .. | 5 | 8 | 43 | 33–52 | 70 | 42–99 | 73 | 64–79 | 58 | 50–67 | 52 | 41–63 |
| *Eugenia francisii* .. | Pink satinash .. | 5 | 15 | 36 | 30–42 | 77 | 63–91 | 64 | 56–71 | 45 | 36–54 | 44 | 36–51 |
| *Euroschinus falcatus* .. | Pink poplar .. | 5 | 18 | 26 | 21–30 | 94 | 45–142 | 50 | 36–64 | 30 | 25–36 | 30 | 25–35 |
| *Evodia micrococca* .. | Silver sycamore .. | 5 | 15 | 29 | 25–33 | 99 | 67–131 | 58 | 47–68 | 35 | 31–40 | 35 | 30–39 |
| *Ficus macrophylla* .. | Brown figwood .. | 5 | 13 | 19 | 13–25 | 144 | 99–190 | 46 | 36–56 | 22 | 16–30 | 22 | 15–29 |
| *Geissois benthami* .. | Brush mahogany .. | 7 | 21 | 31 | 25–37 | 81 | 41–120 | 56 | 43–67 | 38 | 31–45 | 37 | 30–44 |

* The range within which it is estimated that 95 per cent. of the material will fall.

TABLE 1—*continued.*

| Species. | | Range of Material. | | Basic Density lb./cu. ft. | | Green Moisture Content %. | | Green Density lb./cu. ft. | | Air-Dry Density (lb./cu ft.) Before Reconditioning. | | Air-Dry Density (lb./cu ft.) After Reconditioning. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Botanical Name | Common Name. | No. of Trees. | Total No. of Samples. | Mean. | Range.* | Mean. | Range.* | Mean. | Range.* | Mean. | Range.* | Mean. | Range.* |
| *Grevillea robusta* .. | Southern silky oak .. | 3 | 9 | 32 | 29–35 | 118 | 97–139 | 70 | 63–76 | 38 | 34–43 | 38 | 34–41 |
| *Glochidion ferdinandi* .. | Scrubwood .. .. | 6 | 18 | 35 | 31–39 | 83 | 65–101 | 64 | 47–81 | 43 | 39–48 | 42 | 37–47 |
| *Gmelina leichhardtii* .. | White beech .. | 7 | 13 | 28 | 22–34 | 109 | 43–174 | 58 | 42–75 | 34 | 27–40 | 33 | 26–40 |
| *Harpulia pendula* .. | Tulip wood .. .. | 4 | 12 | 46 | 39–52 | 57 | 46–69 | 72 | 62–82 | 56 | 46–67 | 55 | 45–65 |
| *Litsea reticulata* .. | Bolly gum .. .. | 9 | 13 | 26 | 8–44 | 84 | 50–119 | 48 | 34–63 | 31 | 24–39 | 31 | 24–38 |
| *Lucuma amorphosperma* | Apple plum .. | 5 | 15 | 41 | 39–43 | 71 | 55–87 | 70 | 64–76 | 50 | 47–53 | 49 | 47–52 |
| *Melia dubia* .. .. | White cedar.. .. | 6 | 18 | 24 | 21–28 | 64 | 37–90 | 39 | 32–49 | 29 | 25–34 | 29 | 25–34 |
| *Niemeyera prunifera* .. | Black apple .. | 3 | 9 | 38 | 29–48 | 87 | 57–117 | 71 | 65–78 | 49 | 38–60 | 46 | 35–59 |
| *Nothofagus cunninghamii* | Myrtle .. .. | .. | 9 | 36 | 30–41 | 84 | 43–125 | 66 | 52–79 | 43 | 37–50 | 42 | 36–49 |
| *Orites excelsa* .. | Southern silky oak .. | 7 | 21 | 31 | 27–34 | 108 | 87–129 | 64 | 56–71 | 38 | 33–43 | 37 | 32–42 |
| *Owenia venosa* .. | Rose almond .. | 3 | 12 | 46 | 43–50 | 44 | 32–55 | 66 | 60–72 | 57 | 53–62 | 57 | 52–61 |
| *Pinus radiata* .. | Radiata pine .. | .. | 21 | 25 | 20–31 | 87 | .. | 47 | .. | 30 | 23–37 | 30 | 23–37 |
| *Rhodosphaera rhodanthema* | Tulip satinwood .. | 4 | 12 | 36 | 27–45 | 69 | 40–92 | 61 | 42–79 | 43 | 31–55 | 42 | 32–52 |
| *Schizomeria ovata* .. | White birch .. | 10 | 19 | 31 | 26–36 | 84 | 52–116 | 57 | 46–69 | 38 | 32–44 | 37 | 31–44 |
| *Sideroxylon australe* . | Black apple .. | 7 | 21 | 43 | 37–49 | 66 | 40–92 | 72 | 66–77 | 54 | 46–63 | 53 | 45–61 |
| *Sloanea woollsii* .. | Yellow carabeen .. | 6 | 17 | 29 | 23–36 | 83 | 51–115 | 53 | 43–64 | 36 | 28–45 | 35 | 27–43 |
| *Stenocarpus sinuatus* .. | White oak .. .. | 4 | 12 | 37 | 34–40 | 75 | 67–83 | 65 | 61–68 | 48 | 43–54 | 46 | 41–50 |
| *Syncarpia hillis* .. | Satinay .. .. | . | 14 | 40 | 33–48 | 79 | 57–101 | 72 | 68–76 | 52 | 46–59 | 50 | 42–58 |
| *Synoum glandulosum* .. | Red sycamore .. | 4 | 12 | 32 | 26–38 | 101 | 52–151 | 64 | 57–71 | 40 | 32–48 | 38 | 30–47 |
| *Tarrietia actinophylla* .. | Blush tulip oak .. | 9 | 27 | 40 | 33–47 | 69 | 54–84 | 67 | 57–77 | 51 | 40–62 | 50 | 39–61 |
| ,, *argyrodendron* var. *peralata* | Red tulip oak .. | 6 | 77 | 38 | 32–44 | 70 | 49–92 | 65 | 57–73 | 49 | 42–56 | 47 | 40–55 |
| *Tieghemopanax elegans* . | White basswood .. | 7 | 21 | 25 | 22–29 | 97 | 92–102 | 49 | 38–59 | 30 | 26–35 | 30 | 25–35 |
| ,, *murrayi* | Pencil cedar.. . | 3 | 9 | 19 | 16–22 | 108 | 58–157 | 40 | 29–50 | 24 | 19–28 | 22 | 18–27 |
| *Tristania conferta* .. | Brush box .. .. | .. | 21 | 43 | 33–54 | 72 | 61–84 | 74 | 69–80 | 57 | 50–63 | 54 | 48–61 |
| ,, *laurina* .. | Kanuka box .. | 10 | 22 | 38 | 32–44 | 80 | 55–106 | 68 | 55–83 | 53 | 41–64 | 48 | 39–58 |
| *Vitex lignum-vitae* .. | Lignum vitae .. | 5 | 15 | 47 | 41–53 | 56 | 42–70 | 73 | 66–81 | 58 | 51–64 | 56 | 49–62 |
| *Weinmannia lachnocarpa* | Mararie .. .. | 4 | 12 | 45 | 40–51 | 53 | 31–75 | 69 | 63–76 | 56 | 48–63 | 54 | 47–62 |

TABLE 2.—DENSITY FIGURES FOR 113 AUSTRALIAN TIMBERS (LESS THAN 8 SAMPLES).

| Species. | | Range of Material. | | Basic Density (lb./cu. ft.) Mean. | Green Moisture Content (%) Mean. | Green Density (lb./cu. ft.) Mean. | Air-Dry Density (12% Moisture Content). | |
|---|---|---|---|---|---|---|---|---|
| Botanical Name. | Common Name. | No. of Trees. | Total No. of Samples. | | | | Before Re-conditioning (lb./cu. ft.) Mean. | After Re-conditioning (lb./cu. ft.) Mean. |
| *Acacia acuminata* | Jamwood | 4 | 4 | 56 | 39 | 78 | 66 | 66 |
| ,, *aneura* | Mulga | 1 | 1 | 57 | 32 | 75 | 68 | 68 |
| ,, *bakeri* | Marblewood | 1 | 3 | 43 | 68 | 72 | 52 | 52 |
| ,, *decurrens* | Black wattle | 1 | 2 | 36 | 66 | 60 | 45 | 45 |
| ,, *pycnantha* | Golden wattle | 1 | 1 | 41 | 56 | 64 | 51 | 50 |
| ,, *salicina* | Willow wattle | 1 | 2 | 41 | 84 | 75 | 48 | 47 |
| *Acronychia laevis* | Yellowwood | 1 | 3 | 34 | 79 | 61 | 42 | 42 |
| *Akania hillii* | Turnipwood | 1 | 3 | 30 | 120 | 66 | 42 | 37 |
| *Amoora nitidula* | Jimmy-Jimmy | 2 | 6 | 38 | 67 | 63 | 48 | 47 |
| *Atherosperma moschatum* | Tasmanian sassafras | 1 | 1 | 26 | 68 | 44 | 32 | 32 |
| *Backhousia citriodora* | Lemon ironwood | 1 | 3 | 47 | 53 | 72 | 58 | 57 |
| *Banksia marginata* | Honeysuckle | 1 | 1 | 30 | 133 | 70 | 39 | 36 |
| ,, *verticillata* | River banksia | .. | 5 | 25 | 125 | 56 | 30 | 30 |
| *Bosistoa transversa* | Flintwood | 1 | 3 | 45 | 60 | 72 | 59 | 57 |
| *Bridelia exaltata* | Scrub ironbark | 1 | 3 | 40 | 68 | 67 | 48 | 47 |
| *Cadellia monostylis* | .. | 1 | 3 | 40 | 82 | 73 | 49 | 47 |
| *Callicoma serratifolia* | Silvertop | 1 | 3 | 27 | 147 | 67 | 34 | 34 |
| *Cardwellia sublimis* | Northern silky oak | .. | 6 | 26 | 146 | 64 | 30 | 30 |
| *Cassis marksiana* | .. | 1 | 3 | 39 | 60 | 62 | 46 | 46 |
| *Castanospermum australe* | Black bean | 5 | 7 | 38 | 86 | 71 | 46 | 45 |
| *Casuarina luehmanni* | Bull oak | 1 | 3 | 45 | 54 | 69 | 55 | 53 |
| ,, *stricta* | Sheoak | 1 | 1 | 43 | 58 | 68 | 55 | 51 |
| *Cinnamomum virens* | .. | 2 | 6 | 30 | 97 | 59 | 36 | 36 |
| *Cryptocarya foveolata* | .. | 1 | 3 | 37 | 61 | 60 | 46 | 46 |
| *Diospyros australis* | Grey myrtle | 1 | 3 | 33 | 78 | 59 | 40 | 40 |
| *Dissilaria baloghioides* | Red bulletwood | 1 | 3 | 51 | 46 | 74 | 63 | 62 |
| *Dysoxylon rufum* | .. | 1 | 3 | 35 | 89 | 66 | 44 | 43 |
| *Elaeocarpus eumundi* | Silver ooline | 1 | 3 | 39 | 68 | 66 | 48 | 46 |
| *Elattostachys nervosa* | Beerbark | 1 | 3 | 37 | 60 | 59 | 44 | 44 |

TABLE 2—*continued.*

| Species. | | Range of Material. | | Basic Density (lb./cu. ft.) Mean. | Green Moisture Content (%) Mean. | Green Density (lb./cu. ft.) Mean. | Air-Dry Density (12% Moisture Content). | |
|---|---|---|---|---|---|---|---|---|
| Botanical Name. | Common Name. | No. of Trees. | Total No. of Samples. | | | | Before Re-conditioning (lb./cu. ft.) Mean. | After Re-conditioning (lb./cu. ft.) Mean. |
| *Emmenosperma alphitonioides* | Pink ooline | 1 | 3 | 44 | 52 | 67 | 54 | 53 |
| *Endiandra compressa* | Queensland greenheart | 2 | 6 | 50 | 50 | 75 | 62 | 62 |
| „ *crassiflora* | Wild quince | 2 | 6 | 40 | 61 | 64 | 49 | 49 |
| „ *discolor* | Rose walnut | 2 | 6 | 36 | 68 | 61 | 42 | 41 |
| „ *muelleri* | .. | 1 | 3 | 38 | 76 | 67 | 45 | 45 |
| *Erythrina vespertilio* | Grey corkwood | 1 | 3 | 10 | 382 | 50 | 15 | 12 |
| *Eucalyptus acmenoiodes* | White mahogany | 2 | 2 | 49 | 61 | 79 | 60 | 59 |
| „ *albens* | White box | 2 | 2 | 56 | 41 | 79 | 69 | 68 |
| „ *australiana* | Narrow-leaved peppermint | 4 | 4 | 38 | 88 | 72 | 52 | 46 |
| „ *baxteri* | Brown stringybark | 2 | 4 | 36 | 100 | 72 | 46 | 43 |
| „ *bicolor* | Black box | 4 | 5 | 53 | 44 | 76 | 65 | 63 |
| „ *bicostata* | Southern blue gum | 2 | 2 | 43 | 73 | 74 | 58 | 54 |
| „ *bosistoana* | Coast grey box | 4 | 4 | 53 | 48 | 79 | 68 | 66 |
| „ *botryoides* | Bangalay | 5 | 5 | 45 | 66 | 75 | 58 | 55 |
| „ *capitellata* | Brown stringybark | 3 | 3 | 37 | 108 | 77 | 50 | 46 |
| „ *calophylla* | Marri | 4 | 4 | 41 | 86 | 76 | 52 | 51 |
| „ *cladocalyx* | Sugar gum | 1 | 2 | 52 | 43 | 74 | 65 | 63 |
| „ *considениana* | Yertchuk | 3 | 3 | 42 | 73 | 73 | 56 | 52 |
| „ *cornuta* | Yate | 1 | 3 | 50 | 44 | 72 | 67 | 65 |
| „ *crebra* | Narrow-leaved ironbark | 1 | 1 | 44 | 64 | 72 | 56 | 53 |
| „ *dalrympleana* | Mountain gum | 5 | 5 | 32 | 125 | 72 | 42 | 39 |
| „ *diversicolor* | Karri | .. | 6 | 45 | 68 | 76 | 58 | 57 |
| „ *dives* | Broad-leaved peppermint | 3 | 3 | 35 | 98 | 69 | 48 | 42 |
| „ *eugenioides* | White stringybark | 4 | 5 | 40 | 75 | 70 | 53 | 49 |
| „ *fasciculosa* | Pink gum | 1 | 2 | 50 | 47 | 74 | 62 | 60 |
| „ *goniocalyx* | Mountain grey gum | 4 | 4 | 41 | 75 | 72 | 55 | 51 |
| „ *hemiphloia* | Grey box | 5 | 6 | 56 | 37 | 77 | 70 | 69 |
| „ *macrorrhyncha* | Red stringybark | 3 | 3 | 47 | 68 | 79 | 57 | 53 |
| „ *maideni* | Maiden's gum | 2 | 2 | 43 | 60 | 69 | 58 | 54 |

TABLE 2—*continued.*

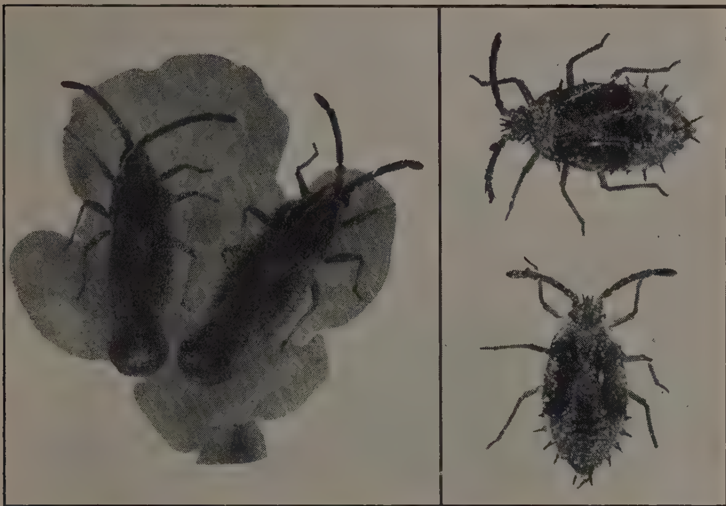
| Species. | | Range of Material. | | Basic Density (lb./cu. ft.) Mean. | Green Moisture Content (%) Mean. | Green Density (lb./cu. ft.) Mean. | Air-Dry Density (12% Moisture Content). | |
|---|---|---|---|---|---|---|---|---|
| Botanical Name. | Common Name. | No. of Trees. | Total No. of Samples. | | | | Before Re-conditioning (lb./cu. ft.) Mean. | After Re-conditioning (lb./cu. ft.) Mean. |
| *Eucalyptus melliodora* | Yellow box | 3 | 3 | 56 | 46 | 82 | 69 | 67 |
| „ *microcorys* | Tallowwood | 4 | 6 | 49 | 54 | 75 | 61 | 59 |
| „ *muelleriana* | Yellow stringybark | 3 | 3 | 43 | 72 | 74 | 54 | 52 |
| „ *nitens* | Shining gum | 3 | 3 | 32 | 119 | 70 | 45 | 40 |
| „ *piperita* | Peppermint | 1 | 2 | 51 | 42 | 72 | 63 | 62 |
| „ *polyanthemos* | Red box | 5 | 7 | 51 | 50 | 76 | 63 | 61 |
| „ *punctata* | Grey gum | 1 | 2 | 48 | 60 | 77 | 61 | 58 |
| „ *resinifera* | Red mahogany | 1 | 2 | 50 | 60 | 80 | 60 | 59 |
| „ *sideraphloia* | Red ironbark | 1 | 2 | 47 | 53 | 72 | 57 | 56 |
| „ *sideroxylon* | Red ironbark | 5 | 6 | 51 | 49 | 76 | 64 | 61 |
| „ *sieberiana* | Silvertop ash | 2 | 2 | 36 | 104 | 73 | 47 | 45 |
| „ *viminalis* | Manna gum | 3 | 3 | 27 | 133 | 63 | 34 | 32 |
| *Eucryphia billardieri* | Leatherwood | 1 | 1 | 34 | 54 | 52 | 42 | 42 |
| *Eugenia australis* | Cherry | 1 | 3 | 32 | 90 | 61 | 40 | 39 |
| „ *brachyandra* | .. | 1 | 3 | 31 | 98 | 61 | 37 | 37 |
| „ *corynantha* | Sour cherry | 2 | 6 | 35 | 82 | 64 | 44 | 43 |
| „ *gustavioides* | Grey satin ash | .. | 4 | 31 | 109 | 65 | 36 | 35 |
| „ *myrtifolia* | Cherry | 2 | 6 | 36 | 95 | 70 | 49 | 45 |
| *Exocarpus cupressiformis* | Wild cherry | 3 | 5 | 35 | 92 | 67 | 42 | 41 |
| *Ficus stephanocarpa* | Sand paper fig | 2 | 6 | 23 | 187 | 66 | 31 | 29 |
| *Flindersia bennettiana* | Bennett's ash | 1 | 3 | 37 | 66 | 62 | 47 | 46 |
| „ *brayleyana* | Queensland maple | .. | 4 | 27 | 88 | 51 | 33 | 32 |
| „ *oxleyana* | Yellowwood | 1 | 1 | 33 | 43 | 47 | 40 | 40 |
| „ *schottiana* | Silver ash | 1 | 3 | 41 | 52 | 62 | 50 | 50 |
| *Geijera salicifolia* | Grey satinheart | 1 | 3 | 46 | 56 | 72 | 57 | 56 |
| *Guioa semiglauca* | .. | 1 | 3 | 39 | 75 | 68 | 47 | 47 |
| *Hemicyclia australasica* | Grey boxwood | 1 | 3 | 40 | 74 | 70 | 50 | 48 |
| *Hodgkinsonia ovatiflora* | .. | 1 | 4 | 39 | 67 | 65 | 47 | 46 |
| *Hymenosporum flavum* | .. | 1 | 3 | 30 | 90 | 57 | 37 | 36 |

TABLE 2—*continued.*

| Species. | | Range of Material. | | Basic Density (lb./cu. ft.) Mean. | Green Moisture Content (%) Mean. | Green Density (lb./cu. ft.) Mean. | Air-Dry Density (12% Moisture Content). | |
|---|---|---|---|---|---|---|---|---|
| Botanical Name. | Common Name. | No. of Trees. | Total No. of Samples. | | | | Before Re-conditioning (lb./cu. ft.) Mean. | After Re-conditioning (lb./cu. ft.) Mean. |
| *Jagera pseudorhus* | White tamarind | 1 | 3 | 34 | 63 | 55 | 41 | 40 |
| *Laportea photiniphylla* | Mulberry leaf stinger | 1 | 3 | 13 | 396 | 65 | .. | .. |
| *Litsea zeylanica* | .. | 1 | 3 | 31 | 67 | 52 | 38 | 37 |
| *Lucuma galactoxylon* | Cairn's pencil cedar | .. | 5 | 24 | 72 | 41 | 28 | 28 |
| *Macadamia praealta* | Bullnut | 2 | 6 | 42 | 61 | 68 | 52 | 50 |
| *Mallotus discolor* | .. | 1 | 3 | 36 | 60 | 58 | 42 | 42 |
| ,, *philippinensis* | Hickory | 1 | 3 | 42 | 57 | 66 | 50 | 50 |
| *Myrtus hillii* | .. | 1 | 3 | 44 | 55 | 68 | 56 | 54 |
| *Olea paniculata* | Shotwood | 1 | 3 | 48 | 53 | 73 | 58 | 57 |
| *Pittosporum rhombifolium* | White holly | 2 | 6 | 36 | 67 | 60 | 44 | 43 |
| *Protium australasicum* | Brown cudgerie | 2 | 6 | 30 | 56 | 47 | 36 | 36 |
| *Pseudomorus brunoniana* | White handlewood | 2 | 4 | 40 | 72 | 69 | 48 | 48 |
| *Rapanea variabilis* | Pink oak | 1 | 3 | 33 | 101 | 66 | 41 | 39 |
| *Rhodamnia argentea* | Brown malletwood | 2 | 6 | 40 | 65 | 66 | 51 | 49 |
| ,, *trinervia* | ,, ,, | 2 | 6 | 35 | 83 | 64 | 44 | 42 |
| *Sarcopteryx stipitata* | .. | 1 | 3 | 45 | 51 | 68 | 57 | 56 |
| *Sideroxylon chartaceum* | .. | 2 | 6 | 49 | 55 | 76 | 61 | 60 |
| ,, *pohlmanianum* | Yellow boxwood | 1 | 3 | 42 | 69 | 71 | 51 | 51 |
| ,, *richardi* | Blush coondoo | 2 | 6 | 36 | 63 | 59 | 44 | 43 |
| *Siphonodon australe* | Ivorywood | 1 | 3 | 39 | 78 | 69 | 51 | 48 |
| *Sloanea australis* | Blush alder | 2 | 5 | 29 | 103 | 59 | 38 | 36 |
| *Stenocarpus salignus* | Red silkyoak | 1 | 3 | 39 | 83 | 72 | 53 | 48 |
| *Syncarpia laurifolia* | Turpentine | 3 | 3 | 43 | 73 | 75 | 61 | 54 |
| ,, *leptopetala* | Ironwood | 1 | 3 | 44 | 71 | 75 | 56 | 55 |
| *Tarrietia argyrodendron* | Brown tulip oak | 2 | 6 | 44 | 56 | 69 | 53 | 53 |
| *Xanthoxylon brachyacanthum* | Thorny yellowwood | 1 | 3 | 37 | 61 | 60 | 46 | 45 |

PLATE 1.

(The Lantana Bug, *Teleonemia lantanae* Distant. See page 181.)



**(a)** **(b)**

FIG. 1.—*Teleonemia lantanae.*—(*a*) Adults on *Lantana* flower. (*b*) 5th instar nymphs. × 10.

FIG. 2.—Eggs of *Teleonemia lantanae* projecting above vein of *Lantana* leaf.

[*Photos by W. James.*

PLATE 2.

(The Lantana Bug, *Teleonemia lantanae* Distant. See page 181.)

Fig. 1.—Leaves of *Lantana* distorted after oviposition of *Teleonemia lantanae.*

Fig. 2.—Colony of *Teleonemia lantanae* feeding on *Lantana* leaf.

[*Photos by W. James.*

PLATE 3.

(The Lantana Bug, *Teleonemia lantanae* Distant. See page 181.)

FIG. 1.—Branch of *Lantana* plant injured by *Teleonemia lantanae.*

FIG. 2.—*Lantana* plant defoliated by *Teleonemia lantanae.*

[*Photos by W. James.*

PLATE 4.

(The Lantana Bug, *Teleonemia lantanae* Distant. See page 181.)

(*a*) (*b*) (*c*)

Fig. 1.—*Teleonemia lantanae* attacked by the fungus *Hirsutella* sp.—
(*a*) Adult, dorsal aspect.
(*b*) Adult, ventral aspect.
(*c*) Nymph, dorsal aspect.

Fig. 2.—Adult Reduviid feeding on nymph of *Teleonemia lantanae*.

[*Photos by W. James.*

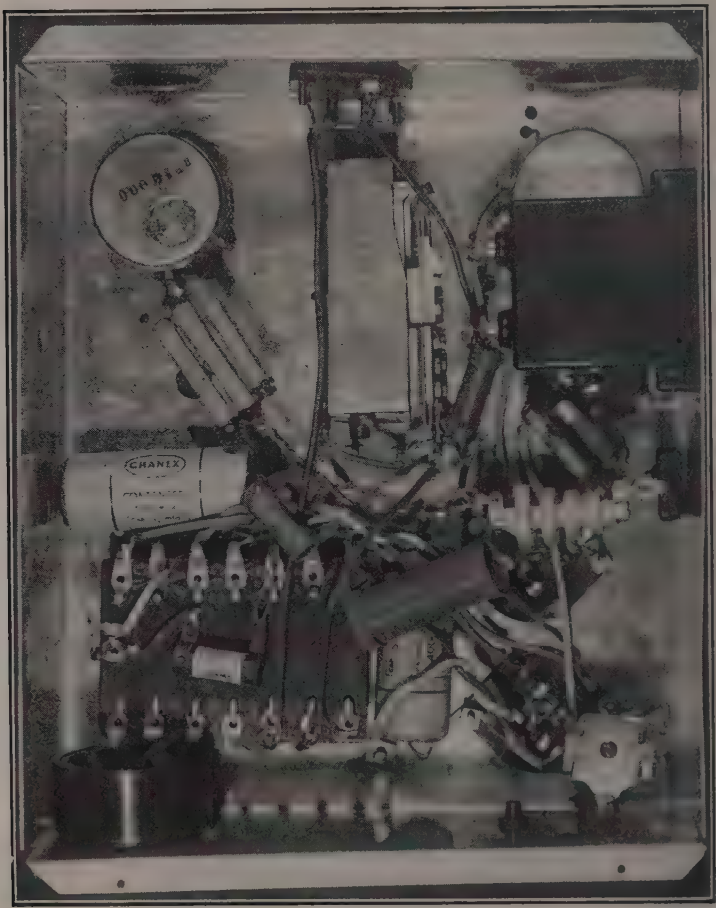
PLATE 5.

(The Determination of the Moisture Content of Timber by Electrical Capacity Effects: A New Meter and its Application. See page 235.)

Fig. 1.—Electrical moisture meter.

Fig. 2.—Meter with box removed.

(The Determination of the Moisture Content of Timber by Electrical Capacity Effects: A New Meter and its Application. See page 235.)




Arrangement of components in instrument.

**PLATE 7.**

(Yellow Dwarf of Tobacco in Australia: I. Symptoms. See page 228.)

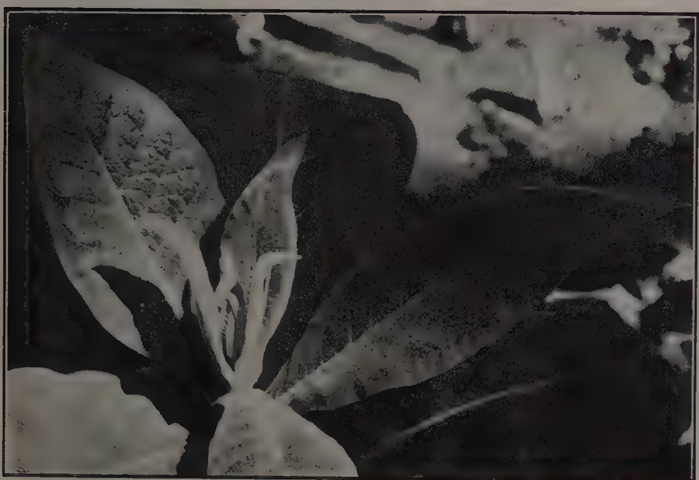


Fig. 1 (*top*).—Left—Tobacco plant affected with yellow dwarf, and Right—An adjoining healthy plant (var. Hickory Pryor) nine weeks after transplanting. Seventy per cent. of the plants in this field were diseased.

Fig. 2 (*bottom*)—The apical portion of a plant (var. Dungowan) affected with yellow dwarf. Note, in the young leaves, rolling under of the margins, bending down of the tips and the ribbed appearance on the under sides. The upper leaf on the right shows depressions between the main lateral veins. The leaf in the foreground was bent down in order to obtain an unobstructed view of the young leaves.

PLATE 8.

(Yellow Dwarf of Tobacco in Australia: I. Symptoms. See page 228.)

FIG. 1 (*top*).—A fully grown plant (var. Hickory Pryor, height 15 in.) that was affected with yellow dwarf a few weeks after transplanting. Note the short internodes, the savoy appearance of the leaves, and that the lower leaves are dead.

FIG. 2 (*bottom*).—A plant affected with yellow dwarf and showing the thickened, rugose leaves. The bottom leaves are yellowed. This plant (var. Yellow Pryor), photographed eight weeks after transplanting, was 15 in. high.

PLATE 9.

(A Laboratory Kiln for the Development of Kiln Drying Schedules.
See page 231.)

FIG. 1.—Front view of open kiln showing stack in position, wet and dry bulbs, heating units, humidifying spray and fan.

PLATE 10.

(A Laboratory Kiln for the Development of Kiln Drying Schedules. See page 231.)

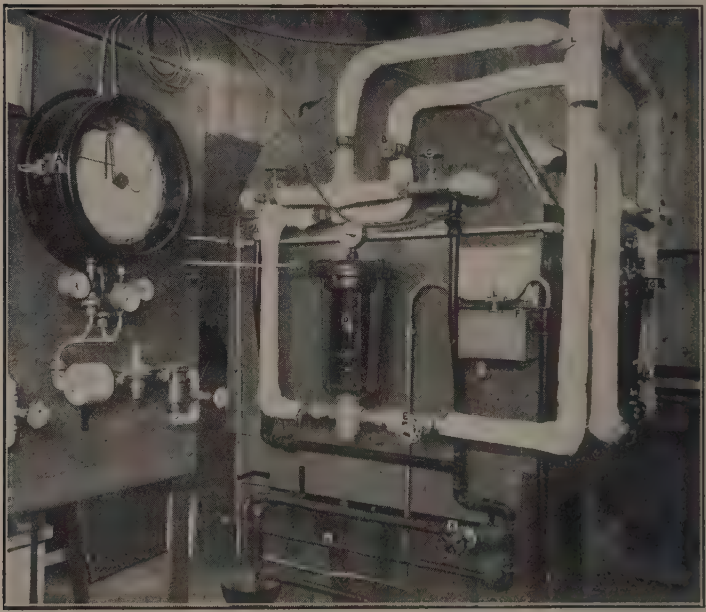


Fig. 2.—View of back and side of kiln showing control instrument and pipe layout.

# NOTES.

## Building Research in Great Britain.

The Annual Report of the British Building Research Board (covering the year 1935-36), copies of which have just become available in Australia, contains much information of general interest.

The Board is now finding that there is a need for a distinct effort to be made to ensure the effective application at the earliest possible time of the results of its Research Station's work. With this need in view, considerable time is being devoted to the preparation of Codes of Practice with the assistance of the professional institutions concerned. Another move in this direction is the decision of the Board to issue a text-book on building. The relevant extract from the Report reads as follows:—

"With regard to the text-book, the need has been felt for some time for an authoritative and up-to-date volume on building. As a result of research activities, progress in building science has been rapid since the war, and an outlook on building materials and construction has been developed which in many ways breaks away from traditional conceptions. Little of this new knowledge has, however, found its way into text-books—it exists in a widely disseminated form in published literature. Consequently it becomes important to consider the collation of the information to provide a review of the whole subject in a form which will bear directly on the practical work of building. The suggestion was advanced by the Committee on the Ministry of Health on the Construction of Flats for the Working Classes, the Royal Institute of British Architects and the Chartered Surveyors' Institution that the Station should undertake the task. It is probably true that the Station, through its research activities and its work in dealing with building troubles, has accumulated a body of knowledge and experience which is unique. It was another matter, however, to decide that it should attempt this ambitious task, in view of the many other pressing calls on it, but we came to the conclusion the work should be undertaken. An Editorial Committee has been appointed to advise in connexion with it (Appendix I.)."

The following extracts from the report of the Director of the Board's Research Station located at Watford are of interest:—

"Generally speaking, it is probably true to say that building has been left untouched to an extent greater than any other form of industrial activity by the developments of science and technology which have taken place in the last century or so. . . . The actual work of building consists in the assembly by the builder of a variety of materials according to the plan of the designer. The efficiency of the work may very largely be influenced by the interaction of materials placed in juxtaposition. For example, cases have been found in which an ordinarily very durable sandstone decays rapidly when used in association with a Portland stone, due to the transference of soluble salts from the latter. So long, of course, as materials of which there had been long experience were used in the traditional fashion, troubles were avoided. But with the development of transport, the builder frequently finds himself using a material which, though generally

similar to those to which he has been accustomed, has slight but obscure differences in properties which may be productive of much trouble unless those differences are recognized and taken into account. Such troubles are in fact of common occurrence. Developments in other industries, resulting in the introduction into the building industry of artificial products of which previously there has been no experience, have increased rather than diminished them. Hitherto, the proper use of materials has depended on craft skill, but something more is wanted to-day. The skill and experience of the craftsman needs to be supplemented by scientific knowledge of materials which will serve to indicate how to avoid unsuccessful work.

"Now it may be said that it is to the interest of the builder to carry out research into the cause of failures so that he may ensure a satisfactory result to his client. But as already indicated, the builder is concerned not with one material but with many, and it is almost a counsel of perfection to expect him to initiate the vast range of work necessary to cover the ground properly. The natural inclination for him is to take the short cut of avoiding materials of which he has had unpleasant experience, and in any case he may well argue that it is equally to the interest of the manufacturer to carry out research so as to ensure a good market for his product. The net result of this division of interest seems to have been that what is everybody's business becomes nobody's business. It was the recognition of this state of affairs that led to the establishment of the Building Research Station as an organization maintained by the State for the purpose of carrying out research into problems of the industry in the interests of the community as a whole.

"It has been noted moreover that conditions to-day are bringing into prominence fresh problems or problems of which there had hitherto been no real appreciation. This fact has well been brought to light by the Departmental Committee of the Ministry of Health on the materials and methods of construction suitable for the building of flats for the working classes, in whose work the Station has collaborated and whose interim report was published in May, 1935. That report brings into prominence three major issues which on the purely technological side probably dwarf other considerations. These are sound insulation, bug infestation, and fire resistance.

"Modern constructional methods have increased the continuity of structural members and brought about in consequence a great increase in the transmission of impact noises. But it is probable that it is the increased and increasing use of many-storeyed blocks of flats both as a solution of the ordinary housing problem in large cities and in connexion with slum clearance that has given rise to the most urgent demands for better insulation against noise.

"The Fire Offices' Committee have undertaken the establishment of suitable equipment and, with the collaboration of the Station on technical points, have erected the new Fire Testing Station at Elstree which is now in operation.

"The essential properties of building materials must be assessable in scientific terms so that, for one thing, any case of failure with the traditional materials may be understood, and, for another, that means may be available for judging the suitability of the new materials which are constantly being put upon the market."

During the year the Station carried out work on a wide variety of building materials, including building stones, bricks, cement, limes and plasters, sands, asphalt, and paint. It also investigated the broad problem of the efficiency of buildings from the stand-point of the user, which investigation involves work on such matters as the testing of panel radiators, the thermal conductance of a brick wall, heat transmission through roofs, the best position of roof glazing, the obstruction of light by balconies, noise transmission, and the like. The Station also carried out, in response to specific inquiries, a number of studies of aggregates, asphalt and bituminous material, corrosion, damp, dry-rot, prevention of flies congregating in buildings, floors, moulds and algae, plasters, &c.

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### Enema Treatment Against Nodule Worm (*Oesophagostomum columbianum*).

In a previous issue (8: 140, 1935), conclusions drawn from some work on the control of the nodule worm which the Division of Animal Health had carried out at the McMaster Laboratory were given.

The Division has now obtained further experience with the method and points out that it is necessary to emphasize the importance of using the correct volume of liquid containing the active principle, sodium arsenite. It has been found that a number of graziers have been administering only 1 quart of solution for grown sheep. Experiments have shown very definitely that such a dose possesses only a very slight degree of efficiency against the nodule worm. It has been found essential to use a dose of 1½–2 quarts for grown sheep in order to obtain a degree of efficiency commensurate with the time and effort required for this method of treatment.

The dose rate varies from 1 pint to 2 quarts according to the size of the sheep. Age is not as important a factor as size. Roughly, however, the dose rates should be as follows:—

| | |
|---|---|
| Lambs 3–4 months .. | 1 pint. |
| Lambs 4–6 months .. | 1–1½ pints. |
| Sheep 6–12 months .. | 1½ pints to 1 quart. |
| Sheep 12–18 months .. | 1–1½ quarts. |
| Grown sheep .. .. | 1½–2 quarts. |

The bulk of the dose is the all important factor in this method of treatment. The amount of sodium arsenite may vary from 125–250 milligrams (2–4 grains) per quart.

With the doses recommended, it is necessary to exercise great care in injecting the enema. It must be done slowly and patiently and with due regard to the reactions of the sheep. Injection of each quart should occupy approximately 1 minute. If the enema is injected carelessly and too fast, danger of causing a rupture of the wall of the bowel is very great.

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### Worms in Sheep—The Use of Bluestone and Nicotine Sulphate.

For some time past, the Division of Animal Health has been carrying out experiments at the McMaster Laboratory with a view to determining the value of bluestone (copper sulphate) and nicotine sulphate in the control of certain internal parasites of sheep. This mixture has proved to possess a reasonable degree of efficiency against

the small intestinal worm (known also as black scour worm, hair worm, &c.) (*Trichostrongylus* spp.) and is recommended specifically for treatment against this parasite. It also possesses efficiency against the tapeworm (*Moniezia* spp.) and the large stomach worm (rennet worm, barber's pole worm) (*Haemonchus contortus*). It probably also possesses some degree of efficiency against the small brown stomach worm (*Ostertagia* spp.).

Black scours (trichostrongylosis) is typically a disease of young sheep, seldom affecting sheep over 18 months old. An exception to this general rule may be the case of grown sheep brought on to "inside" country from "outside" areas where they have not been infested as young sheep and hence have not developed resistance.

It is therefore not necessary to use the bluestone nicotine sulphate mixture as a general treatment for all sheep. It is, in comparison with copper sulphate, an expensive and fairly poisonous mixture, and hence should only be used when necessary. Where grown sheep are to be treated against *Haemonchus contortus*, bluestone alone or carbon tetrachloride should be used.

Experience in the field has shown that the bluestone nicotine sulphate mixture appears to be especially poisonous when used on sheep which are anaemic owing to heavy infestation with the large stomach worm (*Haemonchus contortus*). The mixture should therefore not be used for treatment of such cases.

Great care is necessary in administration of this mixture, for, if the lining membrane of the mouth be injured by carelessly and roughly using syringes or drenching guns, serious ill-effects are likely to follow.

## Investigations on the Red-legged Earth Mite.

The red-legged earth mite (the name is applied to two closely allied species, *Halotydeus destructor* and *Penthaleus major*) is believed to have been accidentally introduced into Western Australia from South Africa in 1917, and has since developed into one of the most troublesome agricultural pests in that State. It is also becoming increasingly prevalent in parts of the south-eastern States. The mite attacks a wide variety of plants; but its destruction of legumes in improved pastures is probably the most serious aspect of the damage it causes. It can be controlled to a certain extent by means of insecticides; but this practice can be applied only to high-value land (such as market gardens) the returns from which justify the expense involved. Considerable reduction in the damage caused by the mite can also be obtained by maintaining a really clean fallow in crop rotation. In pastoral areas, however, neither chemical control nor clean fallow can be applied; and the main hope of dealing with the mite on such land is by biological control.

For some time past the Council's Western Australian State Committee has been giving some attention to the mite problem, in consultation with the University of Western Australia and the State Department of Agriculture. A little time back, too, the Chief of the Council's Division of Economic Entomology, Dr. A. J. Nicholson, visited Western Australia and gave some consideration to the lines along which future investigations might be made.

Arrangements have now been concluded for the carrying out of a programme of work in which the Council, the Western Australian Department of Agriculture, and the University of Western Australia will co-operate. It will consist, in the main, of a study of the effects produced by present agricultural and pastoral practices, and by modifications of these practices, on earth mite populations, and also a preliminary study of insecticides. Mr. K. R. Norris, a graduate of the University of Western Australia, has been appointed as an officer of the Council's Division of Economic Entomology to carry out this work.

Mr. Norris, as a Hackett student at the University of Western Australia, has already carried out certain ecological investigations of the mite. He has now established his headquarters at Katanning in the south of the State, where he will work in close association with an officer of the State Department of Agriculture.

A Committee, representative of the three co-operating parties, and consisting of Mr. E. H. B. Lefroy, Professon J. E. Nichols, Mr. L. Newman, Mr. I Thomas, and Dr. A. J. Nicholson, has been set up generally to assist the investigations. Professor Nichols has undertaken the detailed supervision of the work on behalf of Dr. Nicholson, and also to provide Mr. Norris with laboratory facilities when that investigator is in Perth; Mr. L. W. Phillips has agreed to act as Secretary of the Committee.

It is anticipated that the present programme of work will be completed in about two years when the situation will be reviewed.

Apart from the above-mentioned new co-operative work, the Council's Division of Economic Entomology has been concerned for many years with the whole problem, and has been endeavouring to discover natural enemies which could be introduced to control the pest. The search has been handicapped by the lack of knowledge as to the original home of the mite. It was apparently introduced into South Africa, and no satisfactory natural enemies of the mite have been discovered in that country. There is some reason to believe, however, that it may have come originally from the Mediterranean region, for small local outbreaks of one of the species have been recorded from time to time in the south of France. The nature of these outbreaks suggests that the mite is controlled in this region by natural enemies. Accordingly, the Council's entomologist stationed at Le Lavandou has been instructed to keep a careful watch for outbreaks of the mite, and, should they occur, to give them his full attention, even at the expense of his other work. As yet, however, he has not been successful in discovering a single specimen of the mite.

## Reviews.

### "An Outline of Cytological Technique for Plant Breeders."

The Imperial Bureau of Plant Genetics at Cambridge, England, recently issued a bulletin aiming to give a brief working account of the standard methods used in plant cytology. It is entitled "An Outline of Cytological Technique for Plant Breeders," and is moderately priced at 1s. 6d. As the title indicates, it is chiefly for plant breeders, and is based on practical experience. It therefore does not deal widely with methods such as would be the case in a textbook on methods.

The body of the bulletin covers the paraffin method, staining with iron alum-haemotoxylin and gentian violet, the aceto-carmine method, and smears with standard fixatives and stains. It is introduced by a foreword from Sir Daniel Hall pointing out the need for a knowledge of cytology, and closes with a useful list of fixatives and formulae together with a short bibliography.

B. T. D.

"VEGETATIVE PROPAGATION OF TROPICAL AND SUB-TROPICAL FRUITS*," by G. St. Cl. Feilden and R. J. Garner.

* Imperial Bureau of Fruit Production, East Mailling, Kent, England, Tech. Comm. 7, 1936, pp. 67, bibl. 123, price 2s.

This compilation forms the second of a series of articles issued by the Imperial Bureau of Fruit Production on the vegetative propagation of tropical and sub-tropical horticultural crops, the first on citrus having appeared in 1932. It is in two parts and is based on a thorough examination of existing literature and on the answers to inquiries sent to many workers in the tropics.

In the first part will be found an illustrated and simple account of the different operations of budding, grafting, &c., referred to later. This is very welcome in view of the looseness with which certain propagation terms are used in different part of the English speaking world.

An account follows of the methods commonly recommended for use or trial in the asexual propagation of some 100 types of fruit and references are given to the source of the information in each case.

The biblography concerned precedes a useful index in which both common and scientific names of the plants discussed are included.

Sir Geoffrey Evans, in his introduction, remarks on the completeness of the information and the number of the tropical plants dealt with; it should prove a useful reference work to the topical horticulturist.

"HORTICULTURAL ASPECTS OF WOOLLY APHIS CONTROL TOGETHER WITH A SURVEY OF THE LITERATURE*," by R. M. Greenslade.

* Imperial Bureau of Fruit Production, East Malling, Kent, England, Tech. Comm. 8, 1936, pp. 88, bibls. 555 (general), and 156 (biologic control), price 2s. 6d.

The voluminous literature published during the last hundred years on woolly aphis or American blight, and the divergence of opinion there expressed have long demanded examination and critical analysis.

In November, 1933, a memorandum and questionnaire on the incidence and control of the pest was circulated by the Imperial Bureau of Fruit Production to all the apple-growing countries of the world. The literature and the replies to the questionnaire have been thoroughly sifted by the present author, who has now for some years at East Malling been testing new seedlings for immunity, investigating control measures in the orchard, and studying the causes of immunity or resistance, and is, therefore, in an exceptionally good position for examining the situation. This he does most clearly and concisely for practical horticulturists no less than for fellow-investigators in Technical Communication 8.

First the insect and its habits, its spread in the orchard, its methods of feeding and its possible alternative hosts are dealt with. Next the bearing of climatic factors, temperature, humidity, wind, and sunlight, on its incidence is considered. In many parts of the Empire, the normal combination of these factors is propitious for a heavy attack, whereas in England an increase in temperature and sun, and in Rumania, an increased rainfall will induce it. Control measures are considered in detail:—(1) artificial control including spraying, fumigation, tree injection, cultural practice, &c.; (2) natural control by *Aphelinus mali* and other parasites; the varying measure of success achieved in different countries being noted; (3) control by use of resistant stocks and varieties, a particularly interesting account being given of existing resistant varieties, of the breeding work in progress in England at Merton and East Malling, and of the few indications afforded as yet of the possible causes of resistance; and lastly (4) control by legislation, e.g., quarantine measures, &c.

The literature from nearly 300 sources is further dealt with in two annotated bibliographies. The first, general, contains 555 references, while the second contains 156 references to articles on the biologic control of the pest.

Finally, the memorandum and questionnaire noted previously are reproduced in full together with a list of persons who replied. This list forms, incidentally, a useful index of workers interested in the subject.

Both to investigators and growers, this publication should prove of great reference value.

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## Fourth International Grassland Congress—Abstract of Papers.

The Volume of Abstracts of all papers read or presented at this Congress (Aberystwyth, July 15, 16, and 17, 1937), has just been published in English and German. The Volume is a unique publication in that it brings together in abstract form the opinions and experiences of the chief grassland experts of the world. Subjects discussed range from ecology of grassland and management of pastures to plant breeding and seed production, fertilizers, and questions connected with animal nutrition. There are in all abstracts of 75 papers read by delegates to the Congress from all parts of the world.

The full papers read at Aberystwyth, together with the subsequent discussions, will be published in a report of the Congress to be issued about November, 1937. The Abstracts and complete Proceedings are available for £2 sterling, the Abstract Volume alone for 5s. Copies may be obtained from the Joint Secretaries,, Fourth International Grassland Congress, Aberystwyth, Great Britain.

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## Herbage Abstracts.

The Imperial Bureau of Plant Genetics: Herbage Plants: has recently initiated an addition to its series of publications which should engender an immediate response from all who are interested in maintaining records in good order.

*Herbage Abstracts* beginning with Vol. 7, No. 1 (March, 1937) may be obtained printed on one side of the paper only. The pages of this special issue can be cut up by abstracts and each abstract mounted on an index card, thus saving typing a copy. The arrangement of abstracts under sub-headings of the three major groups of herbage and forage plants, plant biology and agronomy, facilitates the setting up of the card index reference.

The price of this special issue is 20s. p.a., which also includes *Herbage Reviews* printed in the usual way.

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## Recent Publications of the Council.

Since the last issue of this Journal, the following publications of the Council have been issued :—

*Bulletin No.* 105.—" Investigations on the Associated Growth of Herbage Plants." 1. On the Nitrogen Accretion of Pasture Grasses when Grown in Association with Legumes, by H. C. Trumble, M.Agr.Sc., and T. H. Strong, B.Agr.Sc. 2. The Influence of Nitrogen and Phosphorus Treatment on the Yield and Chemical Composition of Wimmera Rye-grass and Subterranean Clover, Grown Separately and in Association, by H. C. Trumble, M.Agr.Sc., and R. E. Shapter, A.A.C.I. 3. The Yield and Nitrogen Content of a Perennial Grass (*Phalaris tuberosa*) when Grown in Association with Annual Legumes, by H. C. Trumble, M.Agr.Sc., and R. E. Shapter, A.A.C.I.

This Bulletin is a progress report on the investigations in which the Council and the Waite Agricultural Research Institute of the University of Adelaide are co-operating. The former Empire Marketing Board, and the Carnegie Corporation of New York have also, in the past, contributed towards the cost of the work.

In the work discussed in the first paper no evidence was obtained that grasses are capable of deriving nitrogen from associated legumes during the vegetative growth of the latter in the winter-growing period of a semi-arid climate. Nitrogen becomes available, however, as a result of nodule breakdown and root decomposition during senescence. The main practical conclusions to be drawn from the work discussed in the second paper are that under conditions of low available nitrogen and phosphorus, such as occur in the podsolised soils of southern Australia, the greatest increases in production are likely to be obtained by the use of suitably inoculated legumes, with liberal dressings of soluble phosphate.

*Bulletin No.* 106.—" Investigations on 'Spotted Wilt' of Tomatoes. III.—Infection in Field Plots," by J. G. Bald, M.Agr.Sc., Ph.D.

This Bulletin is the third of a series dealing with "spotted wilt" of tomatoes. The publication consists of a mathematical and statistical treatment of observed infection rates of the disease. It is shown that the transmission of the disease in the field is due almost entirely to insects.

*Bulletin No.* 107.—" A Soil Survey of the Coomealla, Wentworth (Curlwaa), and Pomona Irrigation Settlements, New South Wales," by T. J. Marshall, M.Agr.Sc., and Allan Walkley, B.Sc., B.A., Ph.D.

The survey discussed in this publication comprised in all some 5,840 acres, including 400 acres of virgin land. The soils of Curlwaa and Pomona, all of which belong to the river flat group, cover a big range of

texture and reaction. Thirteen types have been defined. The soils of Coomealla belong to the broad group of Mallee soils. Ten types have been defined. An outline of general soil conditions and problems in all three areas is given.

*Bulletin No.* 108.—"The Basaltic Soils of Northern Tasmania," by C. G. Stephens, M.Sc.

As its title indicates, the Bulletin contains the results of an examination of the basaltic soils of northern Tasmania; these soils are exclusively associated with flows and intrusions of basalt in Tertiary times. The different soil types can be characterized only by differences in colour and other minor features. The area covered constitutes the only extensive and reasonably continuous area of soils on which a wide variety of crops can be grown in Tasmania. The soils are therefore of great significance in the agricultural welfare of the State. About 80 to 90 per cent. of the State's potato crop, a great proportion of which is shipped to mainland markets, is grown on these soils.

*Pamphlet No.* 69.—"Observations on Some Wool Samples from North-eastern Asia," by H. Munz.

This pamphlet contains results obtained after microscopical and other examination of samples of the more important types of Asian wools obtained a little time back by Dr. I. Clunies Ross during a visit he made to North-eastern Asia in connexion with his survey of the sheep and wool industry of that locality (see Pamphlet 65). A detailed examination of the wool samples, which was carried out by Mr. Munz, has brought out the marked differences between these Asian wools and Australian varieties. All the samples examined, for instance, contained large proportions of kemp, at times ranging up to over 10 per cent. They also contained numerous fibres of an intermediate nature between wool and kemp to which the term heterotype has been given. The poor quality of the samples reflects the difficult climatic conditions with which the wool industry in these countries is faced.

*Pamphlet No.* 70.—"Further Observations on Soil Erosion and Sand Drift, with Special Reference to South-western Queensland," by F. N. Ratcliffe, B.A.

This Pamphlet, being the report of a visit to south-western Queensland made for the purpose of collecting data on wind erosion and sand drift, may be regarded as an extension of Mr. Ratcliffe's previous report on similar problems in the arid pastoral regions of South Australia and published as Pamphlet No. 64. In this last report, Mr. Ratcliffe states that the popularly-held conception of an actively encroaching desert is not borne out by the state of affairs found to exist in south-western Queensland. The winds which blow there do not permit the flow of sand in an easterly or north-westerly direction towards better rainfall country. The sandhill country as a whole seems to be remarkably stable, though individual hills change their conformation, and large quantities of sand are blown about, especially in times of drought. The present distribution and arrangement (often very orderly and regular) of the sandhills are the result of an equilibrium reached between the sand material and the wind forces. The essential weakness of settlement in the region covered is emphasized, as is the importance of adjusting the policy of land tenure and management to the special conditions that exist in the area.

## Forthcoming Publications of the Council.

At the present time, the following future publications of the Council are in the press:—

*Bulletin No. ?*.—" Radio Research Board—Report No. 12."

*Bulletin No. ?*.—" Radio Research Board—Report No. 13."

*Bulletin No.* 109.—" Variability of Plant Density in Fields of Wheat and Its Effect on Yield," by H. Fairfield Smith, B.Sc., M.S.A.

*Bulletin No. ?*.—" Studies in Fertility of Sheep," by R. B. Kelley, D.V.Sc.

*Bulletin No. ?*.—" A Soil Survey of Part of the Denmark Estate, Western Australia," by J. S. Hosking, M.Sc., A.I.C., and G. H. Burvill, B.Sc. (Agric.).

*Pamphlet No.* 71.—" The Effect of Grazing on Improved Pastures Upon the Production of Superfine Wool," by I. Clunies Ross, D.V.Sc., N. P. H. Graham, B.V.Sc., Helen Newton Turner, H. B. Carter, B.V.Sc., and H Munz.

*Pamphlet No.* 72.—" Needle Fusion of Species of *Pinus* in Southern New South Wales," by W. V. Ludbrook, B.Agr.Sc., Ph.D.

*Pamphlet No.* 73.—" Properties of Australian Timbers, Part 2, Brown Mallet (*Euc. astringens*)," by Ian Langlands, B.E.E.

*Pamphlet No. ?*.—" Substances Attractive to Australian Sheep Blowflies," by M. R. Freney, B.Sc.

H. J. Green, Government Printer, Melbourne.

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